APPENDIX J -- PEER REVIEW PANEL COMMENTS ON THE JULY 15, 2002 DRAFT DOCUMENT

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PLANNING & DEVELOPMENT DIVISION
REQUEST FOR EXPERT ASSISTANCE

Tracking Information

Requesting Professionals:	John Zahina, Staff Environmental Scientist
Requesting Department:	Water Supply Department
Project Name:	**Peer Review Panel**: Proposed Minimum Flow Criteria for the Loxahatchee River and Estuary within the South Florida Water Management District
Date:	July 26, 2002

Introduction/Background

It is the intent of the South Florida Water Management District (District) to ensure that all planning documents produced by staff are based on sound scientific principles and best available information. This draft document represents the District's on going contributions towards developing a technical definition of *Minimum Flows and Levels (MFLs)* for the Loxahatchee River and Estuary. Towards these ends, the District seeks to obtain an objective and expert peer review of the revised draft document entitled: *"Technical Documentation to Support Development of Minimum Flows and Levels for the Loxahatchee River and Estuary" (MFL document)*, dated July 15th 2002.

Pursuant to Section 373.042, F.S., Water Management Districts must establish Minimum Flows and Levels for aquifers and surface water courses. The minimum flow for a given watercourse shall be the limit at which further withdrawals would be *significantly harmful* to the water resource or ecology of the area. Specific MFL technical criteria will be established through a state rule development and rule making process, and will be implemented through a multifaceted program of water resource development projects, operations, research and regulation. This peer review is limited to issues regarding establishment of the technical criteria and not to the related implementation process. The District seeks objective review of the technical basis for MFL criteria only (based on best available information); legal interpretations, policy decisions and assumptions are not subject to peer review.

In this effort to develop minimum flows and levels for the Loxahatchee River system, the District identified a narrative definition of "significant harm" as it relates to the MFL statute.

> 'Significant harm' means the temporary loss of water resource functions which result from a change in surface or ground water hydrology that takes more than 2 years to recover, but which is considered less severe than serious harm (Rule 40E-8.021 (24), FAC). 'Serious harm' means the long-term loss of water resource functions, as addressed in Chapters 40E-21 and 40E-22, F.A.C., resulting from a change in surface or groundwater hydrology (Rule 40E-8.021 (23), FAC).

This Statement of Work for panelists is designed to organize an independent scientific peer review pursuant to Section 373.042, FS. (attached). In 2001, an expert peer review panel was assembled to critique the technical aspects of an initial draft of the document, followed by a pubic workshop, Internet feedback, and a final report consolidating the panel's view. As a result of the suggestions and comments by panelists, additional research and technical development were suggested and completed. This second panel review process is intended to provide an objective assessment of the latest draft MFL document and on the MFL criteria proposed therein.

The peer review will be conducted in a manner allowing public participation through Internet access with the panelists. As part of this public process, as required by law, all substantive communications between the panelists regarding this peer review must be conducted through the designated website. Florida Sunshine Law prohibits phone conversations and/or meetings between two or more of the panelists outside of the public's access. Reviewers will be provided specific instructions regarding this process. Cecile Ross, Senior Attorney for Office of Council, will be available to answer any specific question you may have regarding legal issues. Ms. Ross may be contacted at (561) 682-6343, or cross@sfwmd.gov.

The scope of the peer review, under the statute, is very broad with regard to technical or scientific issues. Any scientific assumption, data, and/or modeling results, including assumptions in models, used in the development of the technical criteria are subject to review. However, District Governing Board policy decisions and assumptions are not subject to peer review. The following section is provided to clarify the role of the peer review panel. Staff will also provide further guidance or information on this issue to individual panel members upon their request.

Scope of Work: Policy versus Technical Issues

The responsibility of the peer review panel is to review technical or scientific data, methodologies, and conclusions used in the development of the MFL criteria. The term "technical" is key in understanding the scope of this process. Inherent in developing the proposed criteria is the application of "policies" and interpretations of the MFL statute. These policy considerations are only within the authority of the District's Governing

Board to decide, and should be viewed as assumptions or conditions for the technical review. As a result, it is important to clearly delineate which issues are policy-based and which are within the scope of the technical peer review.

Generally, four types of policy decisions or assumptions were applied in developing the MFL criteria, as described below.

A. Protection of Water Resource Functions

In establishing MFLs, the District must identify and consider the relevant water resource functions of the water body. These functions are set forth in state law and listed in Chapter 1 of the MFL Document. Specific water resource functions for defining significant harm to the Loxahatchee River and Estuary were identified based on their relevance to the level of protection assigned to the significant harm standard, their applicability to the regional nature of the MFL, and the broad scope of District responsibilities under the authorizing statutes. A description of these relevant resource functions for the Loxahatchee River and Estuary is set forth in Chapter 4 of the MFL document.

B. Identification of Baseline Resource Conditions: Statutory "Considerations"

Another type of policy assumption or decision made in the development of the proposed MFL is the definition of the reference point or baseline condition of the subject water resources for which significant harm is to be determined. In establishing MFLs the Governing Board must consider changes and structural alterations to watersheds, surface waters, and aquifers and the effects such changes or alterations have had, on the hydrology of an affected watershed, surface water, or aquifer…" Section 373.0421(1)(a), F.S. (see attached). For example, large drainage systems have been constructed throughout South Florida and development of residential areas has occurred in these drained areas. As a result, in setting a MFL for any remaining natural areas, the Governing Board must also consider the impacts of such drainage and the hydrological limitations that now exist in the system in order to continue to provide flood protection. In that situation, the Governing Board may establish the MFL based on the needs of the impacted natural system, instead of the pre-development conditions. Significant harm is then determined based on how the MFL may impact the water resource function of the water body. Although the peer review panel may not necessarily agree with the policy assumptions made under this statute, it is essential that the peer review be conducted in light of any of these assumptions. The considerations under this statute and how they were applied in developing the proposed Loxahatchee River and Estuary MFL are discussed in Chapter 4 of the MFL document.

C. Level of Protection Provided by the "Significant Harm" Standard

The definition of "significant harm" is also based on previous Governing Board policy decisions and assumptions that are beyond the scope of this peer review. To provide an understanding of this definition, a description of the relevant legal and policy assumptions is provided in Chapter 1 of the MFL document. The applicable narrative definition of "significant harm" is as follows:

'Significant harm' means the temporary loss of water resource functions which result from a change in surface water or ground water hydrology that take more than 2 years to recover, but which is considered less severe than serious harm (Rule 40E-8.021 (24), FAC).

The purpose of the MFL document is to identify the technical or scientific MFL criteria based on this definition of "significant harm." The role of the peer review panel is to review the technical or scientific data, methodologies, and assumptions used in developing the specific MFL for the Loxahatchee River and Estuary.

D. Minimum Flow and Level Versus Restoration

The Minimum Flow and Level developed for the Loxahatchee River is intended to prevent significant harm to the resource. This differs from the concept of "restoration", which seeks to return a portion of the river to some pre-existing historical condition. When reviewing the MFL document, the Peer Review Panel should be aware that the scope of this project is limited to development of the Minimum Flow and Level to protect the resource baseline conditions as described in the Document in Chapter 4 and is not restoration. It should be noted that as restoration plans are developed for the Loxahatchee River, the minimum flow and level may be revised through time to protect those enhanced or restored resource functions.

Some Specifics on Review of Policy and Technical Issues

A list of technical issues considered relevant to the proposed MFL establishment is provided under Task 1 in the Statement of Work. The panel members may also propose additional technical issues, which they identify. The following narrative outlines areas of the MFL document that pertain to the policy or technical aspects of establishing the MFL.

Chapter I summarizes the legal background of the MFL statute and framework of the related laws that apply to the District in Chapter 373, F.S. The panel members are requested to read this chapter and comment on any needed clarification or additional information that would help the reader better understand the logic and basis for the three types of policy decisions or assumptions discussed above.

Chapter II provides a detailed description of the Loxahatchee River, estuary and upstream watershed. Physical and hydrological attributes of the system are set forth, as well as a discussion of the water resource issues affecting the area. The panel members are requested to read this chapter and comment on any needed clarification or additional information that would help the reader better understand the logic and basis for the three types of policy decisions or assumptions discussed above.

Chapter III provides a discussion of (a) key water resource functions of the system that were considered in the development of the MFL, (b) resource protection issues, (c) considerations and exclusions. This chapter is to be reviewed by the panel and comments provided.

Chapter IV identifies the technical or scientific “methods” used in developing the proposed MFL criteria. These "methods” are reviewable technical material and should be critiqued thoroughly by the panel.

Chapter V provides a summary of the scientific approach and technical relationships that were evaluated in defining significant harm for the water body and a detailed presentation of the proposed MFL criteria with supporting documentation. Panel members should review this chapter using the same guidelines for policy versus technical issues consistent with those set for the previous chapters.

Chapter VI outlines the MFL recovery and prevention plan, including implementation policies and process, an evaluation of additional options to obtain water from other basins, and an outline of research needs for the Loxahatchee River and Estuary.

Technical Appendices A-S provide supporting data and information for the technical criteria. These need to be reviewed for accuracy, relevance, and completeness.

Scope of Work (Duties and Tasks of the Peer Review Panelist)

During this project the panelist will:

Task 1: Acknowledge receipt of review materials within 48 hours of delivery

Task 2:

a) Review background materials provided by the District to become familiar with the technical aspects of the proposed MFL criteria and the context of the criteria in existing District policy (not the subject of review)
b) Review comments and suggestions given by the peer review panel for the 2001 Draft MFL Document

Task 3: Read the MFL document and prepare a written review of this document, including a summary, conclusions, and recommendations. The review will include answers to general questions provided by District staff (see below), will comment on how successfully the current MFL document addressed the Panel’s comments/suggestions from the 2001 Peer Review, and how well the technical criteria support the proposed MFL. This review will be submitted in both hard copy and a pre-designated electronic format.

It is requested that all electronic correspondence provided to the District be compatible with Microsoft Word 97.

For services rendered, expert panelists will each receive an honorarium.

Description of Expert Assistance Task (Work Breakdown)

Task 1. Acknowledgement of receipt of Review Materials and Statement of Work

Within two days of receiving the materials, the expert will acknowledge receipt by contacting John Zahina at 561-682-2824 or< jzahina@sfwmd.gov>

Task 2. Review Background Materials and 2001 Peer Review Panel Final Report

Prior to reading the MFL document, experts will review background materials as needed to familiarize themselves with technical aspects of the MFL. The background materials have been provided as reference materials only. Recommendations from the Final Report from the 2001 Peer Review Panel are also to be reviewed.

Task 3. Review Current MFL Document and Write Review Comments

The expert's primary responsibility will be to read and comment on the MFL document with review of the background materials on an as-needed basis. The reviewer will then prepare a review of the document, provide answers to questions provided by District staff, comment on how successfully District Staff has addressed issues from the 2001 Peer Review Panel Final Report, and how well the technical document supports the development of MFL criteria. This includes comments regarding the overall structure and layout of the document, the readability of both text and graphics, and the appropriateness of the document for its intended purpose.

Review comments should address but not be limited to, the **following general questions and technical issues:**

General Questions

1. Does the MFL document present a defensible scientific basis for setting minimum flow criteria for the water body? Are the approaches or concepts described in the document scientifically sound based on 'best available information'?
2. Are the proposed criteria logically supported by 'best available information' presented in the main body of the document? What additions, deletions, or changes are recommended by the Expert to enhance the validity of the document?

3. Are there other technical approaches to setting the criteria that should be considered? Is there available information that has not been considered by the authors? If so, please identify specific technical alternatives to setting the MFLs and the data available to validate the alternative approach.
4. Does the current draft MFL document adequately address the comments provided by the 2001 Peer Review Panel Final Report?

Specific **technical issues** to be evaluated by the Panel include:

The appropriateness of:

- Use and application of the "Valued Ecosystem Component" approach for establishing the MFL
- The proposed minimum freshwater flow regime proposed for the river system during drought conditions
- Completeness of the literature review for the intended purpose
- Statistical analysis and interpretation of historical flow, salinity, and vegetation data
- Methods used to estimate the movement and location of the freshwater-saltwater interface under different flow conditions
- Methods used to characterize the vegetation community composition and distribution
- Linkage or correlation of flow and/or salinity data to impacts to biological communities (has a scientific linkage been clearly established?)
- Use and interpretation of the results of a two-dimensional hydrodynamic-salinity model to describe the effect of various freshwater flow regimes for the river and estuary
- The use of historical hydrological and /or ecological data and findings to determine minimum flow criteria for the River
- Methods or approaches used to define specific "duration" values that are components of the minimum flow criteria for the River

The expert is requested to provide specific recommendations to address any drawbacks or deficiencies in the evidence described in the MFL document for the water resource. It is anticipated that the expert will place emphasis on technical issues and the water resource functions most closely allied with his/her area of expertise. However, comments on any technical aspect of the document are welcome.

Deliverable 1: Acknowledgement of receipt of materials

The July 15, 2002 Draft MFL document has been mailed to Peer Review panelists. *Within two days of receiving this statement of work, the expert will acknowledge receipt by contacting John Zahina at 561-682-2824 or* < jzahina@sfwmd.gov>

Date Due: Within 48 hours of receipt of materials

Deliverable 2:	Review background materials and 2001 Peer Review Panel Final Report
Due Date:	August 21, 2002, within 21 days after acknowledgement of receipt of materials.
Deliverable 3:	Written review of the MFL document, including a summary, conclusions, and recommendations.
Date Due:	August 21, 2002, within 21 days after acknowledgement of receipt of materials.

Responsibilities of Requesting Division

The Project Manager is John Zahina, Staff Environmental Scientist, Planning and Development Division, SFWMD. He will provide the necessary background materials and draft MFL document to each panelist.

Evaluation Criteria for Acceptance of Deliverables

Task 1. Successful completion of Task 1 will be evidenced by judgement of District staff that the Expert was adequately prepared to discuss information in the background materials. The Expert's questions, concerns, and information needs should reflect a thorough review of background materials.

Summary of Time Line and Responsibilities

Task	Responsible Party	Date Due
Task 1: Acknowledge Receipt of Materials from SFWMD	Peer Panel	August 1, 2002 or Two days after receipt
Task 2A: Review Background Materials/Written Review	Peer Panel	August 21, 2002
Task 2B: Review 2001 Peer Review Panel Final Report	Peer Panel	August 21, 2002
Task 3: Provide Written Report of Current MFL Document	Peer Panel	August 21, 2002
Acknowledge Receipt of Written Reports from Peer Panel Experts	John Zahina	August 27, 2002
Issue Payment for Services	John Zahina	August 30, 2002

Payment for Services: Following satisfactory completion of all services required, the panelists will be paid an honorarium or fixed lump sum of $2000.00 for all labor and expenses.

APPENDIX I
Background & Review Materials

Legal Information

- Requirements of MFLs from Florida Statutes, Chapter 373.042 (Appendix L, pg. L-9)
- Final MFL Rule as published in F.A.W. March 30, 2001

Loxahatchee River & Estuary

1. Draft Technical Documentation to Support Development of Minimum Flows and Levels for the Loxahatchee River and Estuary. SFWMD.
2. Draft Appendix A-S, Technical Documentation to Support Development of Minimum Flows and Levels for the Loxahatchee River and Estuary. SFWMD.

Task 3 Reporting

Review of
Draft – Technical Documentation to Support Development of Minimum Flows and Levels for the Loxahatchee River and Estuary

South Florida Water Management District
Water Supply Division
July 15, 2002
Draft

Task 3 Planning & Development Division Request for Expert Assistance requests comment on the current MFL document, addressing General Questions and Specific Technical Issues in the RFA as a basis for that review. This review follows a set of comments made in June 2001. That review included a response to general questions and specific technical issues, similar to this review, and the submission of an overall panel review report.

My review of the revised report will be completed in two parts. The first part provides a general review, directed to the overall document "package" with an emphasis on technical issues and water resource functions. The second part will use the June 2001 comments as a starting point to address how those reviews have been incorporated into the 2002 technical documentation.

Part #1 - General Review

My general review of the 2002 documentation is that this report makes a sound scientific case for the establishment of minimum flows and levels, and presents strong justification for establishing a Loxahatchee River MFL. I find that the report adequately addresses legal and policy factors, relevant water resources functions, considerations and exclusions, and a level of protection based on the MFL standard of significant harm. The report also provides a recovery and prevention strategy, which incorporates adaptive management elements to address uncertainty.

A general comment made about he 2001 draft report was that the organization and presentation could be improved with different placement of text, improvement of illustrations, and careful editing. For the most part, I find that the 2002 Draft has addressed these issues. The present report organization is understandable, although still redundant, and the use of illustrations and data tables is much improved.

I do have a major criticism addressing discussions in multiple sections. This criticism finds that after typically lengthy discussion, where efforts have been made to fully support an argument, that after the conclusions an additional concluding statement is made that qualifies the conclusions. The qualification is often based on data limitations, a lack of full scientific understanding, or other uncertainty, which is common in this type of analysis. There is no doubt that limitations to findings should be clearly identified, but the present approach tends to diminish support for a finding, rather than qualify a finding in relation to expected, and acceptable uncertainty. I would suggest additional editing in Chapter 4 and 5 to address this issue. I found that the detailed technical support in the appendices adequately addresses uncertainty in the various analyses. In the first volume of the technical documentation I would suggest that issues of uncertainty be addressed early in the summary discussion so that the conclusions reached can stand alone. I would also suggest that the editor choose some method of highlighting critical conclusions, such as italics, so that the reader will be better able to connect specific technical findings in each section with the final arguments supporting MFL establishment.

In summary, I found the 2002 draft documentation to be highly responsive to reviewers concerns. In addition to editing and organization, it is clear that the District staff have completed additional supporting assessment and analysis, significantly strengthening the justification for, and the establishment of, minimum flows and levels for the Loxahatchee River and Estuary.

Part #2 - General Questions and Specific Technical Issues

The Request for Expert Assistance identified four general questions, three questions similar to those asked of the 2001 Draft, and a fourth question related to responsiveness to reviews. Because the comments made in 2002 can provide a basis for evaluation of the 2002 draft, and addressing question #4, I have chosen to include my comments from last year, and use those comments as a basis for the review of the 2002 draft.

1. Does the MFL Document present a defensible scientific basis for setting initial minimum flows criteria for the water body?

> *The document presents a good argument, but it fails to provide a fully "scientific" basis for the argument in some circumstances. The major criticism from this reviewer is that a number of unproven assumptions, based on observations or common sense have been introduced as accepted fact with little support, other than the ideas are repeated in the document. For example, the 2 ppt salinity threshold is identified early in the document with little support for its selection (although arguments supporting 2 ppt are made late in the document the general scientific support for this number is weak). Further, the entire document hinges on a proposed relationship between salinity and the selected VEC. Based on the assumption that salinity is the controlling factor of the Cyprus community, the entire document constructs an argument. Unfortunately this argument is often challenged by specific statements in the document. The "scientific" sense of this reviewer is that the foundation for the arguments is sound, but the report in its present organization fails to scientifically substantiate statements based on specific citation of reference documents or more general reference resources from*

> *engineering, ecology, or limnology/oceanography. I do not see this as a fatal flaw of the report, but a problem that must be addressed to provide the most defensible recommendations on MFLs.*

2002 Review

I find that the 2002 draft presents a defensible scientific basis for setting the initial minimum flows criteria. Where the 2002 document often relied on unproven assumptions, the 2002 draft more adequately develops technical arguments, adds critical data on vegetation and soils, and makes better use of model capabilities.

In summary, the revised organization of the report, the addition of additional assessment and analysis data, and the reformulation of how arguments for MFL establishment are integrated finds good technical support for the proposed MFL. In addition, the report specifically identifies the need for adaptive management, and provides a sound assessment and research plan to support future improvement of an established MFL.

The appropriate use of technical support, and the inclusion of adaptive management now takes advantage of the most effective water resources management tools.

1b. Are the approaches or concepts described in the document scientifically sound based on ‘best available information’?

> *In terms of the internal definition of ‘best available information’ generally used in this document, the approaches and concepts are generally sound. This said, the literature support for this report is somewhat limited, and could be expanded to include reference to fundamental physical principles associated with flow and mixing, and basic ecological theory. The report could benefit from a better description of flow input to the watershed (particularly things like groundwater/base flow enhancements associated with wetland restoration), and salt wedge dynamics, particularly as those dynamics are associated with freshwater inflow volumes. Similarly, the concept of VEC could benefit from a better sense of how communities are organized and the requirements for long term stability of ecosystem characteristics in a naturally changing environment. To provide an approach, the authors should consider selected use of sidebars, which will both provide better scientific support, and improve general readability for audiences with variable technical backgrounds.*

2002 Review

Although the range of topics covered in this report could result in a bibliography that is as long as the report text, I find that this report strikes a reasonable balance between full literature documentation and the criticisms made last year. I find that the first volume cites important literature, demonstrating a good sense of background materials. The methods of integration of critical literature resources have been improved, leading to strengthening the technical arguments made in the report. This report has also improved the VEC concept, replacing the dependence on bald Cyprus with the selection of community indicators, again, improving technical support for the arguments made.

2a. Are the proposed technical criteria logically supported by 'best available information' presented in the main body of the document?

> *Although the response to this question parallels the response to question 1a and b, the document may be over dependent on appendices, failing to present sufficient detail in the main body of the document.*

2002 Review

This draft has found a good balance between the technical detail of the appendices and an adequate support for arguments in a summary technical document. I find that the inclusion of detail in the 2002 draft is sufficient to support the arguments made.

2b. What additions, deletions or changes are recommended by the Expert to enhance the validity of the document?

> *Response to this question is, in part, covered in comments to technical issues. In addition, it is expected that many of this expert's detailed comments will be addressed during meetings with staff. It will be at that time that comments from all reviewers will be discussed and integrated into a follow-on plan for document completion.*

2002 Review

The present document is technically sound as presented. My only recommendation for change would be to consider preparation of an executive summary that would be accessible to a wider audience. This summary could briefly establish legal and policy factors and then summarize critical findings in support of the MFL. I can say that I had to wade through lengthly discussions, often with some foreknowledge of where the arguments were headed before a conclusion was reached. For a general audience, the technical analysis process can be simplified, still identifying critical steps, to reach the conclusions made. I think that a more accessible document will improve the support the District seeks from the range of stakeholders who have an interest in this MFL.

3a. Are their other approaches to setting the criteria that should be considered?

> *There are numerous other approaches to setting MFL criteria. Each of these approaches will have a different VEC base and require additional, and even alternate, justifications. That said, there is a critical issue in setting the MFL that has been ignored. In this water resources framework, we might expect the ecological components of the system to respond to concentration, duration, and frequency. In the MFL discussions the issues of concentration and duration have been addressed, but frequency is not included in MFL criteria. Let me suggest*

that a 20 day flow subceedence, followed by a one day exceedence of the criterion flow, followed by another 20 day subceedence will meet MFL criteria, yet create a high potential for ecological damage because of the frequency of reoccurrence.

As soon as the MFL analysis moves into frequency, then the entire "package" must be improved to address seasonal, and other issues. The District might consider this issue very carefully, because it is in the time-scale arena that critical flows can be expected to make a difference. For example, there may be a critical period when Cyprus seedlings must have fresh water. Simply setting a MFL and a duration does little to meet that specific need, and the degradation of the community identified in this report may continue. Adding frequency will significantly alter the report, but consideration of this issue should be a major point of our upcoming discussions.

2002 Review

I was particularly pleased with the recognition of concentration, duration, and frequency as factors affecting the Loxahatchee ecosystem. I feel that District staff have done an excellent job developing the technical documentation that addresses these combined issues of salinity control. I feel that staff has effectively used the modeling tools at their disposal, and collected important additional data that assists in duration and frequency analysis. It is in the application of adaptive strategies based on additional data on duration and frequency that will improve the potential for MFL success. I think the staff has effectively captured issues of variability in this draft.

3b. Is their available information that has not been considered by the authors? If so, please identify specific alternatives to setting the MFLs and the data available to validate the alternative approach.

As mentioned previously, the literature support for this report is generally limited to local studies supporting focused arguments. There are a number of alternate methods for setting MFLs, found in the extensive literature associated with Instream Flow Needs (IFN). The U. S. Fish and Wildlife Service, and now National Biological Survey lead in addressing IFN issues. Alternative approaches, as noted above, will start with the definition of the VEC/target or indicator organism. There are alternatives that consider broader community response models. Rather than respond to this question with specific identification of alternatives, This reviewer suggests that the focus of discussion at our upcoming meeting should be on watershed integration with a systems view to set a MFL that is protective of a range of resources in keeping with the spirit of the Florida regulations. This comment is not intended to suggest an alternative approach, rather it is intended to strengthen the arguments in this report and adequately address a community "vision" appropriate to this watershed.

2002 Review

I find that the District staff has followed up on IFN approaches, and they have developed a community indicator model for analysis that further strengthens a community "vision" appropriate to this watershed.

4. Does the current draft MFL document adequately address the comments provided by the 2001 Peer Review Panel Final Report.

I believe the report has adequately addressed both the details, and the spirit of the 2001 peer review.

Technical Issues

The Statement of Work asked the reviewer to address the appropriateness of ten items (nine items nine common to the 2001 review, item #6 new this year. There is some overlap between these questions and my response to general questions, and there is overlap between technical issues.

1. Use of "Valued Ecosystem Component" approach for establishing the MFL.

> *The VEC is a reasonable approach for establishing a MFL but the support for selection of the specific VEC in this report is weak. For example, the arguments could be strengthened by relating Bald Cyprus to specific ecological community components that could be understood by a wider audience. Comments have already been made about the selection of a single parameter, such as salinity, as the primary control of community characteristics. The VEC discussions should be strengthened. Specific comments will be made in the detailed review.*

2002 Review

The 2002 Draft has made significant alterations to the support of the VEC. The report recognizes the limitations of the use of Bald Cyprus as an indicator, and has developed a new indicator based on 6 VEC species. The change to a community indicator, supported by new analysis of vegetation now provides a good foundation for VEC determination. The VEC indicators have also been used appropriately, in conjunction with hydrologic analyses, to provide a sound argument for MFL determination. I feel that the VEC discussions have been sufficiently strengthened to support the MFL.

2. The proposed minimum freshwater flow regime proposed during drought.

> *Although there is good technical support for the proposed MFL, and the arguments focusing on mile 8 are persuasive to this reviewer, the number still seems to be drawn from a random lot, then supported by modeling that is*

admittedly inadequate and a historical analysis that is very short term (only 6 years) that does not include a drought period. This reviewer also found the inclusion of multiple flow requirements at different locations in the estuary were confusing. Further, the estimates of tributary influence are particularly weak, and should be improved.

This reviewer is fairly critical of the proposed MFL. I can criticize the specificity of the number and the sense that this flow will actually meet multiple ecosystem needs. I believe the support to address both of these criticisms is present in the document, but this support must be sharpened.

2002 Review

I find that the hydrologic analyses are much improved over the 2001 Draft. The 2002 Draft adequately defines the hydrologic setting, and then makes a good argument for a focus on hydrologic conditions that can be controlled. Although the hydrologic models are not 3-dimensional, the models are used well, calibrated effectively, and shown to provide reasonable estimates with sensitivity analyses. I feel that District staff has effectively addressed major hydrologic modeling issues identified in the 2001 Draft.

In addition to improved hydrologic modeling, the 2002 Draft provides a much improved analysis of historical hydrology, using that historical analysis to support duration and frequency assessments, which improve ecosystem analyses and more fully support the proposed MFL.

3. Completeness of the literature review

This reviewer has already made several statements about the literature support.

2002 Review

As noted above, I find a good balance between detail in appendices, and literature cited in the appendices, and the selection of literature used to support the summary document.

4. Statistical analysis and interpretation of historical flow and salinity data.

This reviewer is not sure that a statistical analysis was performed on the flow and salinity data. The document noted that half hourly data on salinity was modified to a daily average and flow was only really addressed in relation to a single input. Further, the major "statistical" analysis was the development of a regression model, which produced results that were verified by comparison to a simulation model that was viewed as limited in the report. Again, I will not criticize the approach because I understand that this approach is about the best that could be done as this report was assembled. That is not to say that the most effective use of available data was made. This reviewer will be very interested in a better description of the data resources represented in Appendix D, in *particular the methods of estimating flow and the actual utilization of salinity data. What is very important is the better support of the duration criterion from this data*.

2002 Review

Another member of the review panel specifically addressed statistical analysis and interpretation issues. I find that the Ds/Db index significantly improves the analysis process. My sense is that the District staff have abandoned the approach criticized last year, substituting improved modeling, improved hydrologic analyses, and an improved method for identifying salinity relationships that include a duration factor in the index.

5. Methods used to estimate the movement and location of the freshwater-saltwater interface under different flow conditions.

    The document itself provides a review of this approach, focusing on the hydrodynamic model and listing limits to the model and the potentials for model improvement. Freshwater/saltwater interactions have been extensively studied. The report establishes 2 ppt as a critical threshold, yet acknowledges a limited understanding of the dynamics of lateral movement of saline waters. The three dimensionality of this problem is critical. The report could be strengthened by development of a simple conceptual model of the freshwater-saltwater interface.

2002 Review

Although I did not find an explicit description of a simple conceptual model, the 2002 Draft has more effectively addressed long term issues, and with the SAVELOX model, provided a method of effectively connecting hydrodynamics and ecosystem value. The report has done a much better job of use of a 2 ppt threshold, and provided useful alternatives that support comparison of alternatives. It is in this area that I think the District staff has made the biggest step in integrating assessment and analyses to support the MFL. Although I could suggest additional data collection or analyses to better support models, the inclusion of an adaptive management element, which accepts uncertainty in data, models, and decisions suggests that District staff fully recognize limitations, and through research planning, will improve modeling, analysis, and assessment tools as monitoring results are obtained.

6. Methods used to characterize the vegetation community composition and distribution.

2002 Review

A major weakness of the 2001 Draft was the over dependence on Bald Cypress analysis in the vegetation assessment. The 2002 Draft has addressed that weakness, and strengthened the vegetation analysis with better analysis of historical aerial photography, additional assessments at critical locations, and an improved VEC analysis approach.

As in any ecological study, data may not be sufficient to fully support all management or decision requirements. I feel the 2002 Draft has sufficiently strengthened the vegetation community analysis to fully support the MFL recommendation.

7. Linkage or correlation of flow and/or salinity data to impact to biological communities (has a scientific linkage been clearly established?).

   Comments related to this technical question could be extensive, and will likely be the focus of considerable discussion during the site visit. I have already made comments concerning single parameter emphasis, and the expansion of discussions that might occur as VEC concepts are extended to better portray community/ecosystem relationships. I do not believe that sufficient technical support has been provided in this argument.

2002 Review

The approach used to link flow, salinity, and VEC effect is much more sophisticated in the 2002 Draft report. With re-characterization of river miles, and better correlation of past studies, and improved VEC analysis the 2002 Draft does a good job of relating salinity and vegetation impact. The addition of soil sampling, although raising questions about suitability of salinity or Cl measurements, does add a further dimension to this analysis – improving our general understanding of processes and mechanisms operational in the Loxahatchee River. In summary, I feel the correlation of flow and salinity, particularly the incorporation of duration and frequency elements does a much better job of creating the scientific linkage needed for MFL establishment. Again, where scientific linkages are weak, the adaptive management/future monitoring efforts should add needed information to improve MFLs in the future.

8. Use and interpretation of the results of a two-dimensional hydrodynamic-salinity model.

   I have responded in #5 above, noting that the document provides a review of model limitations and application. It is noted that there are anticipated modifications that should improve model predictions. Further use of the model should be a focus of upcoming discussions.

2002 Review

I find that comments made above address the use and interpretation of models. I find that the 2002 Draft makes much better use of modeling, particularly the integration of modeling and additional assessments to strengthen confidence in the overall process.

9. Use of historical hydrological and/or ecological data and findings to determine a minimum flow criteria for the river.

> *The document has made excellent use of historical vegetation analysis. A possible improvement would be a listing and brief analysis of the historical trends in other ecological data such as fisheries, bird counts, etc.*
>
> *With an emphasis on in-channel hydrology, the report is particularly weak in defining freshwater inputs, other than from the Lainhart Dam. A particular point of discussion should be the possible addition of runoff modeling for critical watershed components to better predict tributary inflow.*

2002 Review

I find that the 2002 Draft makes much better use of historical hydrological and ecological data. The improved approach to long term salinity simulations, the community approach to VEC is a sufficiently strong argument that fisheries and macroinvertebrate data are sufficient to support vegetation analyses.

10. Methods or approaches used to define specific “duration” criteria.

> *As noted above, in addition to duration, it will be critical to define frequency.*
>
> *The arguments supporting a duration are admittedly weak. This reviewer wonders if better support for duration could be found in existing data. For example the continuous monitoring study produced salinity data at 30 minute time intervals for approximately 30 days at a deployment. This data may be useful in better defining salinity parameters that would be useful in duration criteria development. It should be recognized that duration issues are fundamentally biological and the arguments associated with Cyprus effects were particularly weak/unsupported by research. The primary method of improvement of the duration criteria will be the development of better biological response data.*

2002 Review

I have already commented on the improvements in duration and frequency analysis in the 2002 Draft. I feel that the analyses do now support the inclusion of a duration in the technical criteria.

Peer Review Comments

By

Donald M. Kent, Ph.D.
Community Watershed Fund

On

Technical Documentation to Support Development of Minimum Flows and Levels for the Loxahatchee River and Estuary

South Florida Water Management District
15 July 2002 Draft

The South Florida Water Management District (District) must establish Minimum Flows and Levels (MFL) for the Loxahatchee River and Estuary pursuant to 373.042 F.S. A minimum flow is defined as the "… limit at which further withdrawals would be significantly harmful to the water resources or ecology of the area." The minimum level is defined as the "limit at which further withdrawals would be significantly harmful to the water resources of the area." Significant harm is defined as the "…temporary loss of water resource functions which result from a change in surface water or ground water hydrology that take more than 2 years to recover …" (Rule 40E-8.021[24], FAC). For the Northwest Fork of the Loxahatchee River, significant harm is defined as:

- two or more of the six VEC species are not longer present
- the total number of species present is reduced by about one-third
- the floodplain swamp high canopy is no longer present
- seedlings of the six VEC species are no longer present
- daily mean salinity levels range from 0 to 9 ppt with a mean of 0.97 ppt and a 90^{th} percentile limit of 2.9 ppt.

In support of the Loxahatchee River and Estuary MFL effort, the District seeks an objective peer review of any scientific assumption, data and/or modeling results used in the development of technical criteria. Said review will consist of a written review of the *Technical Documentation to Support Development of Minimum Flows and Levels for the Loxahatchee River and Estuary* (15 July 2002 Draft), including:

- answers to general questions provided by District staff
- comments on how successfully the current MFL document addressed the Panel's 2001 Peer Review Final Report
- how well the technical criteria support the proposed MFL.

In addition, the peer review will evaluate specific technical issues as listed in the *Planning & Development Division Request for Expert Assistance* dated 26 July 2002. These issues include:

- use and application of the "Valued Ecosystem Component" approach for establishing the MFL
- the proposed minimum freshwater flow regime proposed for the river system during drought conditions
- completeness of the literature review for the intended purpose
- statistical analysis and interpretation of historical flow, salinity and vegetation data
- methods used to estimate the movement and location of the freshwater-saltwater interface under different flow conditions
- methods used to characterize the vegetation community composition and distribution
- linkage or correlation of flow and /or salinity data to impacts to biological communities
- use and interpretation of the results of a two-dimensional hydrodynamic-salinity model to describe the effect of various freshwater flow regimes for the river and estuary
- the use of historical hydrological and /or ecological data and findings to determine minimum flow criteria for the River
- methods or approaches used to define specific "duration" values that are components of the minimum flow criteria for the River.

District legal and policy decisions further define the scope of the peer review. The review is to consider only the development of the MFL (and not MFL implementation). The review is to accept the water resource functions identified by the District. The review is to accept the District's opinion that the most critical need is to provide a minimum flow criteria that would protect the Northwest Fork River from significant harm, and that providing said criteria will protect other parts of the Loxahatchee River.

The 15 July 2002 Draft MFL document substantially improves upon the 22 May 2001 Draft. However, my interpretation of the findings suggests a different minimum flow at the Lainhart Dam. The final minimum flow criteria, regardless of its value, should be related to other flows to the Northwest Fork and to other parts of the Loxahatchee River and Estuary.

General Questions

1. Does the MFL document present a defensible scientific basis for setting minimum flow criteria for the water body? Are the approaches or concepts described in the document scientifically sound based on 'best available information'?

The District has done a good job presenting a defensible scientific basis for setting minimum flow criteria for the Wild and Scenic River part of the Northwest Fork of the Loxahatchee River and Estuary. The MFL document describes the River and Estuary in sufficient detail, including climate, physical features, hydrology, biological and water resources, and nearby land uses. In addition, the MFL document and appendices describe in adequate detail the methods and information used to develop the MFL criteria. For the most part, the approaches and concepts described in the MFL document are scientifically sound and based upon best available information. Nevertheless, finalization of the MFL criteria may benefit from additional consideration of:

- flows from other tributaries
- other factors that might affect vegetation community location and condition
- potential impacts to other parts of the Loxahatchee River and Estuary
- the relationship between 2 ppt salinity and vegetation community location and condition
- soil salinity transects
- the SAVELOX model.

The MFL document describes and discusses in sufficient detail historic, current and anticipated flows over the Lainhart Dam. Also, the document describes the relationship of Lainhart Dam flow to Northwest Fork salinity both empirically and as modeled by the hydrodynamic/salinity model. Collectively, this information supports a reasoned assessment of the Lainhart Dam flow necessary to sustain desired vegetation communities downstream to Cypress Creek. However, beginning with Cypress Creek, nearly 50 percent of the flow to the Northwest Fork comes from tributaries. Therefore, an assessment based upon flow over Lainhart Dam must ensure that absolute and relative flow from other sources is maintained. Alternatively, the assessment must incorporate anticipated changes in flow from these other sources.

Salinity is convincingly the primary factor determining the location and condition of the floodplain swamp and mangrove communities. However, water quantity may be an important factor in determining the location and condition of stream swamp and cypress within the upper reaches of the Northwest Fork and its tributaries. For example, parts of the middle and upper Northwest Fork and Kitching Creek (Segments 2, 3 and 5 of Figure B-3) have consistently been characterized by freshwater, but the vegetation community has changed from cypress to stream swamp. The MFL document should be explicit about whether the goal is cypress, stream swamp or either. If the goal is cypress, then the effect of changes in flow on freshwater vegetation community location and condition should be evaluated.

Legal and policy decisions have limited MFL criteria development to the Northwest Fork of the Loxahatchee River and Estuary. Nevertheless, potential impacts (positive and negative) to other parts of the system should be evaluated and the results described. For example, the Estuary provides numerous resource functions including habitat to protected species (e.g., Johnson’s seagrass, *Halophila johnsonii*; West Indian manatee, *Trichechus manatus latirostris*). The District recognizes that a “… viable estuarine ecosystem requires a proper balance of freshwater inflow…”(Chapter 3), but the document fails to discuss if this balance will be achieved and by what means the balance will be evaluated.

The MFL document may give undue weight to 2 ppt salinity. Both the hydrodynamic/salinity model and the SAVELOX model appear to directly equate 2 ppt salinity to salt water, and to indirectly suggest that 2 ppt is threshold for the stream swamp. The former is a useful mechanism for estimating the relative position of fresh water and salt water. However, there is no basis presented for a relationship between 2 ppt and vegetation type. In fact, model results suggest that a mean salinity of 0.15 ppt is related to the occurrence of a healthy stream swamp community. Table 25 (p. 101) also suggests that a healthy stream swamp community requires a mean salinity of < 1 ppt.

Results of soil salinity transects are a welcome addition to the MFL document. Soil salinity may be as important, if not more important, than water salinity in determining the location and condition of the stream swamp community. However, a comparison of the transect locations with plots of historic and existing vegetation (e.g., Figure B-3) suggest that samples were collected in areas that have not experienced changes in vegetation. Presumably, soils in these areas have not experienced significant variation in salinity. An evaluation of soil salinity affects on vegetation community may be enhanced by samples collected at locations subject to changes in vegetation community and exposure to salt water, and locations with stressed stream swamp communities. Said samples would help us understand the cumulative effects of salt exposure, and allow the construct of a relationship between soil salinity and stream swamp condition.

The vegetation survey results and the hydrodynamic/salinity model afforded a tremendous opportunity to evaluate the relationship between vegetation community and river salinity. As the District recognizes, vegetation could be responding to certain salinity levels or salinity ranges, the duration of a particular salinity event, the frequency of a particular salinity event, or other factors. SAVELOX manages these potentially confounding variables by creating a new variable D_s/D_b (duration of exposure/time between exposures) as a surrogate for long-term salinity conditions. This is an admirable attempt to integrate the various salinity factors. Our understanding of the relationship between vegetation community and salinity may also benefit from an examination the relationship between vegetation community and individual salinity factors, and combinations of salinity factors. If this has not already been accomplished, the District might consider the use of step-wise regression analysis.

2. *Are the proposed criteria logically supported by 'best available information' presented in the main body of the document? What additions, deletions or changes are recommended by the Expert to enhance the validity of the document?*

The District has demonstrated that a healthy stream swamp community exists at River Mile (RM) 10.2. RM 10.2 has a mean salinity of 0.15 ppt. Salinity intrusion events above 1 ppt and 30 days duration occur once every 1.6 years, events above 2 ppt and 22 days duration occur once every 5.9 years, and events above 3 ppt occur once every 30 years. The District intends to reproduce the RM 10.2 salinity regime at RM 9.2.

The proposed MFL criteria is based on a desire to prevent the salinity at RM 9.2 from exceeding 2 ppt for any longer than has occurred within the healthy swamp community (i.e., no more than 20 days duration more often than once every six years). The document then concludes that Table 40 can be used to select a flow over Lainhart

Dam of 35 cfs to maintain mean daily salinity below 2 ppt at RM 9.2. However, a flow of 35 ppt in Table 40 corresponds to ≤ 2 ppt for 30 days once every four years, and not a mean salinity of 0.15 ppt and the duration and frequency parameters for RM 10.2 (see above) intended to be mimicked for RM 9.2.

The MFL criteria is also predicated on the belief that vegetation at RM 10.2 is healthy, vegetation at RM 9.2 has suffered significant harm, and that vegetation between these two stations has been harmed (but not significantly). However, the significant harm criteria applied to the vegetation between RM 9.2 and RM 10.2 suggests that much of this area has also suffered significant harm. Three VEC species are missing at RM 9.3 and two VEC species are missing at RM 9.7 (one species is missing at RM 9.9). Also, seedlings for four of the six VEC species are missing from the community between RM 9.2 and RM 10.2. Perhaps the definition of significant harm should be clarified to indicate whether all conditions must be satisfied, or whether failure to satisfy one of the criteria is sufficient to designate significant harm.

Significant harm for the vegetation community between RM 9.2 and RM 10.2 can be avoided by reproducing salinity conditions at RM 10.2. According to Table 37, a flow of 50 cfs at the Lainhart Dam will produce a mean salinity of 0.14 ppt at RM 10.2. A flow of 100 cfs at the Lainhart Dam will produce a comparable salinity condition at RM 9.2, and by extension at intervening locations. Flows less than 100 cfs will likely eliminate mature individuals or seedlings of the six VEC species, and thus impart significant harm.

3. Are there other technical approaches to setting the criteria that should be considered? Is there available information that has not been considered by the authors? (If so, please identify specific technical alternatives to setting the MFLs and the data available to validate the alternative approach).

The District has expended considerable effort in investigating and evaluating technical approaches for setting the criteria. No other technical approaches are recommended, other than those previously noted.

4. Does the current draft MFL document adequately address the comments provided by the 2001 Peer Review Panel Final Report?

The Panel's task is not to judge the adequacy of the District's response to our 2001 Report, but to provide advice and allow the District to judge the value of said advice. That being said, the current draft MFL document responds to some, but not all, of the comments in the 2001 Peer Review Panel Final Report. The readability of the text and figures has been improved, although careful proofreading of both is still required. Regarding organizational recommendations, the document has been reorganized to emphasize the technical analysis and modeling of salinity conditions. The document has not been reorganized to provide a section on the expected impact of flow modification on the Loxahatchee River and Estuary. Nor does the document provide MFL recommendations for the North Fork, Southwest Fork or the Estuary.

So too, the current document responds to only some of the Panel's technical comments. For example, the current document addresses the question of whether mangroves continue to encroach on the stream swamp community, inflow data for the entire Estuary, and the inadequacy of information relating cypress condition to salinity. Conversely, the current document fails to address the Panel's comments about anticipated regional growth and development, feasibility of proposed actions, the inadequacy of a linear approach to flow and discharge relationships, and a lag between Lainhart Dam flow data and downstream salinity.

Specific Technical Issues

The appropriateness of:

use and application of the "Valued Ecosystem Component" approach for establishing the MFL

The VEC approach has merit, and can be a valuable tool for management decision-making when the value of the selected ecosystem component is clearly established, and the relationship between the selected ecosystem component and other ecosystem components is clearly defined. The VEC approach for the Loxahatchee River and Estuary MFL was improved in this draft by replacing cypress with six stream swamp tree species. In this manner, the relationship between the VEC and the stream swamp community is more clearly defined. However, the use of six stream swamp tree species has not clarified the relationship between the VEC and other Loxahatchee River and Estuary ecosystem components. Of particular concern is the absence of an identifiable relationship with estuary resource functions.

the proposed minimum freshwater flow regime proposed for the river system during drought conditions

As discussed above, the proposed minimum freshwater flow regime does not demonstrably protect the river system during drought. The proposed flow would seem to maintain stress and/or deteriorating conditions in the stream swamp community, and the effects on the remainder of the Loxahatchee River and Estuary are indeterminate.

completeness of the literature review for the intended purpose

The literature review is reasonably complete for the intended purpose, if the purpose is solely the protection of the stream swamp community in the upper reaches of the Northwest Fork. The literature review should be expanded if it is also the purpose of the MFL criteria to protect the Loxahatchee River Estuary.

statistical analysis and interpretation of historical flow, salinity and vegetation data

For the most part, the statistical analyses of historical flow, salinity and vegetation data are appropriate. The District's efforts indicate due diligence, and a willingness to be innovative. As noted above, the hydrodynamic/salinity and SAVELOX models include an assumption that 2ppt salinity is a critical threshold for the stream swamp community. This assumption should be verified or removed.

Also as noted above, my interpretation of the data have led to different conclusions. Specifically, I note the potential influence of water quantity in determining the nature of the stream swamp community, and a need for a minimum average flow of about 100 cfs over the Lainhart Dam to maintain a stream swamp community at RM 9.2.

methods used to estimate the movement and location of the freshwater-saltwater interface under different flow conditions

The methods used to estimate the movement and location of the freshwater-saltwater interface under different flow conditions are appropriate and reasonable for estimating salinity conditions along the Northwest Fork of the Loxahatchee River.

methods used to characterize the vegetation community composition and distribution

The methods used to characterize the vegetation community composition and distribution are appropriate and reasonable.

linkage or correlation of flow and /or salinity data to impacts to biological communities

The methods used to correlate flow and/or salinity data to impacts are appropriate except where noted. Soil salinity samples should be collected at intervening stations along the Northwest Fork, and the data used to examine the relationship between soil salinity and vegetation type. The 2 ppt salinity threshold implicit in the models should be verified or eliminated.

use and interpretation of the results of a two-dimensional hydrodynamic-salinity model to describe the effect of various freshwater flow regimes for the river and estuary

The two-dimensional hydrodynamic-salinity model is a useful device to describe the effect of various freshwater flow regimes for the river and estuary. The model was put to good use, except when a 2 ppt salinity value was assumed to have significance for the vegetation community.

the use of historical hydrological and /or ecological data and findings to determine minimum flow criteria for the River

The use of historical hydrological and/or ecological data and findings were used appropriately to determine minimum flow criteria for the Northwest Fork, although the findings are subject to interpretation (see above). Historical hydrological and/or ecological data should be applied to a minimum flow criteria for other parts of the Loxahatchee River and Estuary, especially the latter.

methods or approaches used to define specific "duration" values that are components of the minimum flow criteria for the River

Defining specific duration values for the minimum flow criteria is a difficult task. The approach taken by the District is innovative and illustrates a determination to make the best decision possible. Undoubtedly, the duration estimates derived from the analyses are educated guesses. Nevertheless, the criteria is better served with their inclusion than without.

Conclusions

The District has demonstrated considerable diligence in obtaining and analyzing hydrological, salinity and vegetation data for the Northwest Fork of the Loxahatchee River. The hydrodynamic/salinity model and the SAVELOX model are appropriate and reasonable approaches to defining ecosystem component relationships and deriving a minimum flow criteria. As noted above, we differ in our final interpretation of an appropriate minimum flow criteria. The minimum flows and levels process for the Loxahatchee River and Estuary may benefit from review of data interpretation. Also, the minimum flow over the Lainhart Dam must be linked with flows from other tributaries of the Northwest Fork.

Focus on the upper reaches of the Northwest Fork was a policy decision, and therefore beyond the purview of the expert review. Nevertheless, I urge the District to more fully evaluate the consequences of any final minimum flow over the Lainhart Dam on other parts of the Loxahatchee River and Estuary.

Recommendations

- Establish with minimum flow criteria for other tributaries of the Northwest Fork, and connect these criteria with the minimum flow criteria for the Lainhart Dam.
- Determine the effect of water quantity on type of freshwater vegetation community in the upper reaches of the Northwest Fork.
- Evaluate potential impacts to other parts of the Loxahatchee River and Estuary from the minimum flow criteria for the Lainhart Dam.
- Verify the relationship between 2 ppt salinity and vegetation community or eliminate the assumption from the models.
- Conduct soil salinity sampling at intervening locations and re-evaluate the relationship between soil salinity and vegetation community.
- Evaluate the relationship between individual and combined salinity variables and vegetation community.
- Establish a monitoring program to determine the effectiveness of the final minimum flow criteria.

SFWMD Draft Response to Peer Review Comments of Donald M. Kent, Ph.D. for the July 2002 Draft Loxahatchee River MFL Technical Documents

Dr. Kent made the following comments concerning the methods, approach, and documentation of the proposed MFL:

Page 2, 3rd Paragraph: *The 15 July 2002 Draft MFL document substantially improves upon the 22 May 2001 Draft. However, my interpretation of the findings suggests a different minimum flow at the Lainhart Dam. The final minimum flow criteria, regardless of its value, should be related to other flows to the Northwest Fork and to other parts of the Loxahatchee River and Estuary.*

Page 3, 1st Paragraph: *The District has done a good job presenting a defensible scientific basis for setting minimum flow criteria for the Wild and Scenic River part of the Northwest Fork of the Loxahatchee River and Estuary. The MFL document describes the River and Estuary in sufficient detail, including climate, physical features, hydrology, biological and water resources, and nearby land uses. In addition, the MFL document and appendices describe in adequate detail the methods and information used to develop the MFL criteria. For the most part, the approaches and concepts described in the MFL document are scientifically sound and based upon best available information…The MFL document describes and discusses in sufficient detail historic, current and anticipated flows over the Lainhart Dam. Also, the document describes the relationship of Lainhart Dam flow to Northwest Fork salinity both empirically and as modeled by the hydrodynamic/salinity model. Collectively, this information supports a reasoned assessment of the Lainhart Dam flow necessary to sustain desired vegetation communities downstream to Cypress Creek. However, beginning with Cypress Creek, nearly 50 percent of the flow to the Northwest Fork comes from tributaries. Therefore, an assessment based upon flow over Lainhart Dam must ensure that absolute and relative flow from other sources is maintained. Alternatively, the assessment must incorporate anticipated changes in flow from these other sources…Salinity is convincingly the primary factor determining the location and condition of the floodplain swamp and mangrove communities.*

Page 4, 3rd Paragraph: *Results of soil salinity transects are a welcome addition to the MFL document. Soil salinity may be as important, if not more important, than water salinity in determining the location and condition of the stream swamp community.*

Page 4, 4th Paragraph: *The vegetation survey results and the hydrodynamic/salinity model afforded a tremendous opportunity to evaluate the relationship between vegetation community and river salinity. As the District recognizes, vegetation could be responding to certain salinity levels or salinity ranges, the duration of a particular salinity event, the frequency of a particular salinity event, or other factors. SAVELOX manages these potentially confounding variables by creating a new variable* D_s/D_b *(duration of exposure/time between exposures) as a surrogate for long-term salinity conditions. This is an admirable attempt to integrate the various salinity factors. Our understanding of the relationship between vegetation community and salinity may also benefit from an examination the relationship between vegetation community and individual salinity factors, and combinations of salinity factors. If this has not already been accomplished, the District might consider the use of step-wise regression analysis.*

Page 5, 5th Paragraph: *The District has expended considerable effort in investigating and evaluating technical approaches for setting the criteria. No other technical approaches are recommended, other than those previously noted.*

Page 6, 3rd Paragraph: *The VEC approach has merit, and can be a valuable tool for management decision-making when the value of the selected ecosystem component is clearly established, and the relationship between the selected ecosystem component and other ecosystem components is clearly defined.*

The VEC approach for the Loxahatchee River and Estuary MFL was improved in this draft by replacing cypress with six stream swamp tree species. In this manner, the relationship between the VEC and the stream swamp community is more clearly defined.

Page 7, 2nd Paragraph: *The literature review is reasonably complete for the intended purpose, if the purpose is solely the protection of the stream swamp community in the upper reaches of the Northwest Fork.*

Page 7, 3rd Paragraph: *For the most part, the statistical analyses of historical flow, salinity and vegetation data are appropriate. The District's efforts indicate due diligence, and a willingness to be innovative.*

Page 7, 5th Paragraph: *The methods used to estimate the movement and location of the freshwater-saltwater interface under different flow conditions are appropriate and reasonable for estimating salinity conditions along the Northwest Fork of the Loxahatchee River.*

Page 7, 6th Paragraph: *The methods used to characterize the vegetation community composition and distribution are appropriate and reasonable.*

Page 8, 1st Paragraph: *The two-dimensional hydrodynamic-salinity model is a useful device to describe the effect of various freshwater flow regimes for the river and estuary.*

Page 8, 3rd Paragraph: *Defining specific duration values for the minimum flow criteria is a difficult task. The approach taken by the District is innovative and illustrates a determination to make the best decision possible. Undoubtedly, the duration estimates derived from the analyses are educated guesses. Nevertheless, the criteria are better served with their inclusion than without.*

Page 8, 4th Paragraph: *The District has demonstrated considerable diligence in obtaining and analyzing hydrological, salinity and vegetation data for the Northwest Fork of the Loxahatchee River. The hydrodynamic/salinity model and the SAVELOX model are appropriate and reasonable approaches to defining ecosystem component relationships and deriving minimum flow criteria.*

Dr. Kent expressed the following concerns regarding the Draft document:

Page 3, 2nd Paragraph: *The MFL document describes and discusses in sufficient detail historic, current and anticipated flows over the Lainhart Dam. Also, the document describes the relationship of Lainhart Dam flow to Northwest Fork salinity both empirically and as modeled by the hydrodynamic/salinity model. Collectively, this information supports a reasoned assessment of the Lainhart Dam flow necessary to sustain desired vegetation communities downstream to Cypress Creek.* ***However, beginning with Cypress Creek, nearly 50 percent of the flow to the Northwest Fork comes from tributaries. Therefore, an assessment based upon flow over Lainhart Dam must ensure that absolute and relative flow from other sources is maintained. Alternatively, the assessment must incorporate anticipated changes in flow from these other sources.***

- **District Staff's Response**: The flow analysis used to develop the MFL criteria were based upon best available information. Flows from the other tributaries were included in the analysis, however measured flows were not available from Cypress Creek or Hobe Grove Ditch after 1991. The percent of flow contributed by the Lainhart Dam to the NW Fork in the model is 44%. This compares with field measurements that show the Lainhart Dam to provide 45% of the flow for the 1980-81 drought dry season, 46% from the 1980-81 drought wet season, 40% from the 1989-90 drought dry season, and 56% from the 1989-90 drought wet season. Based on these data, the flow ratio of 44% provided in the model appears to be a reasonable ratio for estimating the flow contribution provided by the Lainhart Dam and other tributaries during dry periods, the period of time when a minimum flow would be of interest.

The District has recently completed a contract with the USGS to update and improve the current flow/salinity monitoring program within the watershed. Additional flow gages and salinity monitoring instruments are being installed in Cypress Creek and Hobe Grove Ditch. These additional gages will provide the data needed to more fully understanding the role that these tributary basins play in shaping the river's salinity profile.

Page 3, 3rd Paragraph: *Salinity is convincingly the primary factor determining the location and condition of the floodplain swamp and mangrove communities. However, water quantity may be an important factor in determining the location and condition of stream swamp and cypress within the upper reaches of the Northwest Fork and its tributaries. For example, parts of the middle and upper Northwest Fork and Kitching Creek (Segments 2, 3 and 5 of Figure B-3) have consistently been characterized by freshwater, but the vegetation community has changed from cypress to stream swamp.* ***The MFL document should be explicit about whether the goal is cypress, stream swamp or either. If the goal is cypress, then the effect of changes in flow on freshwater vegetation community location and condition should be evaluated.***

- **District Staff's Response**: The reviewer correctly points out an inconsistency in the information contained in the Figures contained in Appendix B and Table 33 in the main text of the report. This will be corrected. District staff were unable to distinguish between the categories of stream swamp and cypress in the 1940 aerial, so we cannot say there has been change from one freshwater swamp type to another (i.e. stream swamp & cypress swamp). The legends of the above mentioned figures must be changed and the text must be modified to reflect this problem in interpretation.

Page 4, 1st Paragraph: *Legal and policy decisions have limited MFL criteria development to the Northwest Fork of the Loxahatchee River and Estuary.* ***Nevertheless, potential impacts (positive and negative) to other parts of the system should be evaluated and the results described.*** *For example, the Estuary provides numerous resource functions including habitat to protected species (e.g., Johnson's seagrass, Halophila johnsonii; West Indian manatee, Trichechus manatus latirostris). The District recognizes that a "… viable estuarine ecosystem requires a proper balance of freshwater inflow…"(Chapter 3), but the document fails to discuss if this balance will be achieved and by what means the balance will be evaluated.*

- **District Staff's Response**: A section needs to be added to the Chapter 5 (results) that explains the effects of the proposed MFL on conditions and resources in the estuary.

  An effort was made to characterize significant resources that exist in the estuarine portion of the Loxahatchee system (Chapter 2 pages 22-31). These included primarily mangrove swamp communities, other saltwater marsh vegetation, seagrasses and marine algae, fishes, macroinvertebrates and manatees. Our present (very limited) understanding of the relationships between these system components and freshwater inflows was also described. The Loxahatchee estuary covers the entire range from a primarily marine environment near the inlet and into the central embayment to a completely freshwater environment in the upper reaches of he Northwest Fork.

  Physical features of the estuary are summarized on pages 17-21. The North Fork portion of the estuary is very small in extent and has very limited resources due to several factors. The lower reaches have been extensively bulkheaded and filled, effectively eliminating important shoreline habitat. In addition, large areas of the bottom consist of soft mud or ooze that is not conducive to supporting estuarine benthic communities. The upper reaches within Jonathon Dickinson State Park in this section of the North Fork Loxahatchee River have steep shorelines that do not support significant amounts of marsh or swamp shoreline vegetation.

  The Southwest Fork is very small in size and has limited resources, probably due to the relatively frequent large discharges of freshwater from S-46 that result in scouring of the substrate and rapid and extreme salinity changes.

  None of the resources or issues in the North Fork or Southwest Fork of the estuary was considered to have a significant function that would be impacted by low flow conditions. In contrast, the resources of the Northwest Fork, Central Embayment and adjacent coastal waters are primarily sensitive to high flow events. When large discharges of several thousand cfs occur through the S-46 structure into the Southwest Fork, the entire system can become freshwater, which has significant adverse effects on marine life, especially seagrasses and benthic macroinvertebrates, and results in displacement and loss of habitat for fishes that prefer the more saline conditions.

It appears to us that low flow conditions in the Northwest Fork do not have any significant adverse effects on the estuary and may in fact be beneficial rather than harmful to these resources. Under very low flow conditions (see Appendix F, Figure F-4), most of the estuary becomes a marine system (30-35 ppt salinities). If these low flow/high salinity conditions persist for several weeks or months, seagrass communities may tend to expand upstream, providing more habitat and food for marine and estuarine fishes and invertebrates, additional stabilization of soft mud bottom communities and provide additional food for manatees. There may be some mortality occurring in oyster communities at the upper end of the Northwest Fork and some associated recruitment occurring further upstream.

The upper reaches of the Northwest Fork still contain extensive areas of habitat suitable for oysters, as well as oligohaline and freshwater habitat. Extreme fluctuations in salinity, associated with periodic low flow events, are not conducive to the development of extensive oyster communities. Oysters are very beneficial to coastal estuaries such as the Loxahatchee River because they tend to stabilize bottom sediments, provide filtration of suspended materials from the water column and provide an extensive surface area and substrate for colonization of other organisms.

The importance of a stable and extensive oligohaline zone to the health of the estuary has been well studied and documented in a nearby coastal system, the St. Lucie Estuary, located just a few miles north of the Loxahatchee River. Unfortunately, we do not have the same type of extensive data for the Loxahatchee River, although the limited studies we have suggest that the species composition of fishes and macroinvetebrates in these two systems are similar. The Loxahatchee River has more extensive and healthier seagrass and oyster communities, as a total proportion of the area of the estuary, than are found in the St. Lucie Estuary.

In the St. Lucie Estuary we were able to identify the oligohaline zone as the resource that was of primary concern in this system, that this resource would be significantly impacted by reduction of freshwater flow, and therefore needed to be protected by establishment of a MFL. We therefore proceeded to quantify the amount of oligohaline habitat that was lost to the estuary during periods of low flow and identify a critical point in the flow regime when the amount of freshwater entering the estuary from tributary flow was less than the amount of water that was being lost to the system due to evaporation.

By contrast, in the Loxahatchee River system, we have identified the freshwater swamp community in the river floodplain as the primary resource that needs to be protected by establishment of a MFL and (have largely assumed) that the estuary portion of the system will benefit from this improved flow regime by receiving a more stable flow regime that will provide more stable habitat conditions.

The effect of implementing the proposed MFL on this system is anticipated to help further improve conditions in the estuary by providing for a more extensive and stable oligohaline zone (less than 5 ppt salinity) upstream in the river between mile marker 9.2 and 8.5 or so, than occurs at present. Conditions that are more conducive to the growth of oysters on mangrove roots and the formation of oyster reefs or bars (15-25 ppt salinity) are expected to occur in the vicinity of mile marker 6 along the river. At the same time, these flows are not expected to adversely affect the marine communities that live in the central embayment, especially the Johnson's' seagrass community that exists near the railroad bridge.

Page 4, 2nd Paragraph: ***The MFL document may give undue weight to 2-ppt salinity. Both the hydrodynamic/salinity model and the SAVELOX model appear to directly equate 2 ppt salinity to salt water, and to indirectly suggest that 2 ppt is threshold for the stream swamp***. *The former is a useful mechanism for estimating the relative position of fresh water and salt water. However, there is no basis* *presented for a relationship between 2 ppt and vegetation type. In fact, model results suggest that a mean salinity of 0.15 ppt is related to the occurrence of a healthy stream swamp community. Table 25 (p. 101) also suggests that a healthy stream swamp community requires a mean salinity of < 1 ppt.*

- **District Staff's Response**: The 2-ppt salinity value comes from a review of historical salinity trends (as simulated by the model) experienced at river mile 10.2. The point we were trying to convey is that within this remaining "healthy" freshwater community, 2 ppt was near the maximum salinity value recorded over the 30-year period. Given this salinity history, this portion of the river still appears to support a healthy freshwater vegetation community even though salinity events of this magnitude (up to 2 ppt) occur approximately once ever 6 years for an average of 20 days duration. We used this data to characterize the upper limit at which these communities appear to tolerate using best available information. We did not intend to imply that the 2 ppt is any kind of scientifically derived threshold value that characterizes saltwater conditions, other than that is what appears to have happened at these sites over time based on the modeled salinity history.

  It should also be noted that the 2-ppt salinity concentration represented in the model is the daily mean. In other words, salinity could range from 0 to 4 ppt throughout the daily tidal cycle, but the mean salinity would be 2 ppt. A mean daily concentration of 1 ppt would indicate that daily salinity concentrations would vary from 0 to 2 ppt, and is found at the location on the NW Fork where salinity is 0 ppt during low tide and can reach 2 ppt only during high tide. At this site, predominantly freshwater conditions (less than 1-ppt) would occur during the period between high tides. Under these conditions, river channel salinity above 1 ppt would be transient, lasting only a few hours before the next tidal cycle would change the river channel water back to predominantly freshwater conditions. It is felt that with the flushing of salinity between high tides and the predominance of freshwater conditions, significant harm would most likely not occur when mean daily concentrations occasionally were at 1 ppt. For this reason, 2 ppt (the next integer higher) was chosen as a better number to use to define the threshold salinity concentration at which significant harm could occur. Furthermore, the model used to derive these salinities is not sufficiently sensitive to reliably resolve salinity values to 0.1, or even 0.5, whole numbers should be used.

  It is recognized that a healthy stream swamp community requires a mean salinity of < 1ppt (as Dr. Kent described above) and an associated flow to maintain that freshwater state. However, the MFL is concerned with the lowest allowable flow rate, duration and return frequency that would cause significant harm, not the average flow condition at a particular site. At river mile 10.2, salinity did increase above 2 ppt for short durations during extremely dry years. For that reason, it was calculated that a daily mean concentration of 2 ppt (as defined by the model) should not occur for longer than 20 days once every 6 years. This also assumes that freshwater conditions are dominating that site the rest of the time by District's operational policy of delivering 50 cfs to the NW Fork of the river (via G-92 and the Lainhart Dam) when upstream water is available.

Page 4, 3rd Paragraph: *Results of soil salinity transects are a welcome addition to the MFL document. Soil salinity may be as important, if not more important, than water salinity in determining the location and condition of the stream swamp community. However, a comparison of the transect locations with plots of historic and existing vegetation (e.g., Figure B-3) suggest that samples were collected in areas that have not experienced changes in vegetation. Presumably, soils in these areas have not experienced significant variation in salinity.* ***An evaluation of soil salinity affects on vegetation community may be enhanced by samples collected at locations subject to changes in vegetation community and exposure to salt water, and locations with stressed stream swamp communities****. Said samples would help us understand the cumulative effects of salt exposure, and allow the construct of a relationship between soil salinity and stream swamp condition.*

- **District Staff's Response**: Soil transect site #3 was in a location of the river where some changes in the local plant community (stress), due to salinity, were observed. These included the presence of some red mangrove, abundance of pond apple, and the lack of Virginia willow. The semiquantiative survey also showed a reduction in the number of species observed. The field study data from this site can be found in Appendix C. Unfortunately, the results of the quantitative vegetation survey from this site was not included in the analysis presented in the technical document, since only one bank was surveyed and not both (as with the other sites). It is believed that these changes have occurred since the 1970's (based on aerial photo-interpretation presented in Appendix B). The four soil sampling transects represented a salinity non-impacted site (transect 1), rarely impacted site (transect 2), regularly impacted site (transect 3), and highly impacted site (transect 4) along the NW Fork. This was explained on page G-2 on Appendix G. We can further emphasize this by rewriting and clarifying this description of the sites.

Page 5, 2nd Paragraph: *The proposed MFL criteria is based on a desire to prevent the salinity at RM 9.2 from exceeding 2 ppt for any longer than has occurred within the healthy swamp community (i.e., no more than 20 days duration more often than once every six years). The document then concludes that Table 40 can be used to select a flow over Lainhart Dam of 35 cfs to maintain mean daily salinity below 2 ppt at RM 9.2. However, a flow of 35 ppt in Table 40 corresponds to ≤ 2 ppt for 30 days once every four years, and not a mean salinity of 0.15 ppt and the duration and frequency parameters for RM 10.2 (see above) intended to be mimicked for RM 9.2.*

- **District Staff's Response:** There were some errors in the table and associated text and the table was not formatted or explained adequately. The following is a revised Table 40 and explanation.

Table 40 Various Salinity parameters that can be used to protect the resource

River Mile	Approximate Flows (cfs)* needed to maintain salinity concentrations:				
	Mean = 0.15 ppt	Mean = 0.3 ppt	Salinity ≥ 1ppt Not to exceed 31 days/1.6 yr**	Salinity ≥ 2ppt Not to exceed 22 days/5.9yr	Salinity ≥ 3 ppt Not to exceed 14 days/10yr
10.2	50	**35**	20	10	5
9.7	80	50	**32**	25	15
9.2	100	70	47	**35**	**22**
8.9	140	85	60	42	**27**
8.6	150	120	75	55	42
8.35	200	130	80	65	52

* Flows obtained from Table 37 for a given salinity value at a given station location

** Occurrence frequency and duration were obtained from Table 36: for example for 1ppt salinity at station 10.2 *Ds* = 31 days and *Db* = 576 days or 1.6 years; Likewise at 2-ppt salinity, *Ds* =22 days and *Db*=2157 days or 5.9 years

The intent was to display an array of management criteria that could be used as the basis for "transferring" the hydrologic regime from Mile Marker 10.2 down to various downstream mile markers to RM 8.35. The basis of this table is the Ds and Db values listed in Table 36 and the flow required to maintain a given salinity value as listed in Table 37. Thus if the desired intent is to use a mean salinity concentration of less than 0.15 ppt as the management criterion, it can be seen from the first column in Table 37 that a mean flow of 50 cfs is needed to provide this salinity regime at station 10.2 and a mean flow of 100 cfs is needed to provide this mean salinity at station 9.2. Similarly, if the intent is to use a salinity exposure of 2 ppt as the management criterion then, according to Table 36, such an event occurs only 22 days every six years at station 10.2 and (from Table 37 column 2, bottom row) is associated with a flow of 10 cfs. To transfer a comparable salinity exposure of 2 ppt downstream to river mile 9.2, a flow of 35 cfs (Table 37 column 5, 4th row from the bottom) should be allowed to occur no more often than 22 days every 5.9 years.

Page 5, 3rd Paragraph: *The MFL criteria is also predicated on the belief that vegetation at RM 10.2 is healthy, vegetation at RM 9.2 has suffered significant harm, and that vegetation between these two stations has been harmed (but not significantly). However, the significant harm criteria applied to the vegetation between RM 9.2 and RM 10.2 suggests that much of this area has also suffered significant harm. Three VEC species are missing at RM 9.3 and two VEC species are missing at RM 9.7 (one species is missing at RM 9.9). Also, seedlings for four of the six VEC species are missing from the community between RM 9.2 and RM 10.2. Perhaps the definition of significant harm should be clarified to indicate whether all conditions must be satisfied, or whether failure to satisfy one of the criteria is sufficient to designate significant harm.*

- **District Staff's Response**: Many of these concerns could be addressed by implementing a more comprehensive data collection and sampling program to eliminate some of the sources of variation noted above, such as whether the absence of a particular species at a particular point in the rive was due to sampling limitations or natural variability in distributions rather than the effect of salinity. Loss of any one of the VEC species from the canopy structure, to the extent that it could be reasonably be inferred to be due to salinity stress or toxicity, would arguably be considered a significant impact, in that several years (at least) of stable freshwater conditions would be required in order for it to regrow to the extent that its role in the canopy structure would be restored.

Page 5, 4th Paragraph: *Significant harm for the vegetation community between RM 9.2 and RM 10.2 can be avoided by reproducing salinity conditions at RM 10.2. According to Table 37, a flow of 50 cfs at the Lainhart Dam will produce a mean salinity of 0.14 ppt at RM 10.2. A flow of 100 cfs at the Lainhart Dam will produce a comparable salinity condition at RM 9.2, and by extension at intervening locations. Flows less than 100 cfs will likely eliminate mature individuals or seedlings of the six VEC species, and thus impart significant harm.*

- **District Staff's Response**: Please see our previous response to *Page 4, 2nd Paragraph.*

Page 6, 1st Paragraph: "…***The document has not been reorganized to provide a section on the expected impact of flow modification on the Loxahatchee River and Estuary. Nor does the document provide MFL recommendations for the North Fork, Southwest Fork or the Estuary….*** *the current document addresses the question of whether mangroves continue to encroach on the stream swamp community, inflow data for the entire Estuary, and the inadequacy of information relating cypress condition to salinity. Conversely, the current document fails to address the Panel's comments about anticipated regional growth and development, feasibility of proposed actions, the inadequacy of a linear approach to flow and discharge relationships, and a lag between Lainhart Dam flow data and downstream salinity.*

- **District Staff's Response**: The effects of anticipated regional growth and development on water resources in the region are being addressed through the development of a "MFL Recovery Plan" as required by state law (Ch. 373.042(1) for those water bodies which do not presently meet the proposed MFL. The Northern Palm Beach County Comprehensive Water Management Plan (NPBCCWMP) addressed this issue in considerable detail to define water sources and anticipated uses over the next 20 years and determine projects that are needed to ensure that additional water is provided to the Loxahatchee River to meet and exceed the proposed MFL. Approximately $40 million will be spent over the next 15 years to implement this plan. In addition, the Northern Palm Beach County Component of CERP is presently being modified to consider growth, development, water supply, regional storage and flow restoration needs for the Loxahatchee River and its entire watershed. This program anticipates expenditures about $400 million to build long-term storage facilities and provide connections between the Loxahatchee River and regional water management facilities.

  The regression method used initially to develop relationships between flow and salinity was a non-linear technique (see Appendix D, pages D-1 to D-10), but the Excel spreadsheet application for this purpose was shown to be inadequate. SAS was used to develop an improved non-linear relationship, but this approach also was felt by District staff to have some significant predictive limitations. Lag times of 3, 6 9 and 12 days were incorporated into the SAS analysis in an attempt to improve the results, but did not result in a significant improvement in correlation values (Pages D-11 to D-22). It was felt that neither of these regression approaches was especially useful and provided very limited capability to extrapolate beyond known data sets or incorporate alternative modeling scenarios that might involve modification of flows from the different sources.

  For this reason it was decided to move forward with development and use of the hydrodynamic model as recommended in the initial peer review as a means to quantify flow and salinity relationships for the river.

Page 6, 3rd Paragraph: *The VEC approach has merit, and can be a valuable tool for management decision-making when the value of the selected ecosystem component is clearly established, and the relationship between the selected ecosystem component and other ecosystem components is clearly defined. The VEC approach for the Loxahatchee River and Estuary MFL was improved in this draft by replacing cypress with six stream swamp tree species. In this manner, the relationship between the VEC and the stream swamp community is more clearly defined.* ***However, the use of six stream swamp tree species has not clarified the relationship between the VEC and other Loxahatchee River and Estuary ecosystem components. Of particular concern is the absence of an identifiable relationship with estuary resource functions.***

- **District Staff Response**: The District's approach was to successively establish and build a sequence of inferred relationships 1) between flow and salinity, 2) between flow, salinity, tree distribution and the amount of flow needed to sustain the tree community, 3) between the amount of flow needed to sustain the tree community and the resulting salinity distribution in the estuary (Appendix F), and 4) between known presence and distribution of major species in the estuary and information from field observations and literature concerning likely effects of the resulting salinity conditions on these species.

Page 7, 2nd Paragraph: *The literature review is reasonably complete for the intended purpose, if the purpose is solely the protection of the stream swamp community in the upper reaches of the Northwest Fork.* ***The literature review should be expanded if it is also the purpose of the MFL criteria to protect the Loxahatchee River Estuary.***

- **District Staff's Response**: Comment noted.

Page 8, 2nd Paragraph: *The use of historical hydrological and/or ecological data and findings were used appropriately to determine minimum flow criteria for the Northwest Fork, although the findings are subject to interpretation (see above). Historical hydrological and/or ecological data should be applied to a minimum flow criterion for other parts of the Loxahatchee River and Estuary, especially the latter.*

- **District Staff's Response**: We have some potential capability to expand our look at historical conditions in the estuary. Certainly it would be interesting to examine historical aerial photography of mangroves and saltmarsh communities throughout the estuary (from the inlet up through all three forks) in 1940 and compare it with the distribution of these communities today. We have some historical information (largely anecdotal) on fishing conditions in the river and we have some information on the distribution of oysters, based on associated dredging/removal activities that have occurred during the past fifty years. We also have information concerning seagrass distribution, since this has largely occurred since the inlet was stabilized. The extent of submerged freshwater vegetation in the river or estuary prior to opening of the inlet is unknown.

Summary of Recommendations from Dr. Kent:

1. Establish with minimum flow criteria for other tributaries of the Northwest Fork, and connect these criteria with the minimum flow criteria for the Lainhart Dam.
2. Determine the effect of water quantity on type of freshwater vegetation community in the upper reaches of the Northwest Fork.
3. Evaluate potential impacts to other parts of the Loxahatchee River and Estuary from the minimum flow criteria for the Lainhart Dam.
4. Verify the relationship between 2-ppt salinity and vegetation community or eliminate the assumption from the models.
5. Conduct soil salinity sampling at intervening locations and re-evaluate the relationship between soil salinity and vegetation community.

6. Evaluate the relationship between individual and combined salinity variables and vegetation community.
7. Establish a monitoring program to determine the effectiveness of the final minimum flow criteria.

District Response to each bullet:

1. Data collection efforts are being initiated to address this issue
2. The SaveLox model is being further refined as a possible means to address this issue during the restoration effort.
3. VEC study underway -- salinity relationships have been fairly well established. Need a more comprehensive resource inventory of the estuary.
5. Additional soil salinity monitoring should be considered as part of any additional field research that is being conducted in the floodplain
6. The relationship between individual and combined salinity variables and vegetation communities should be investigated further as part of the restoration effort. Infrequent high flows have not been defined for this effort, but we have defined some threshold impact criteria, mean flows and salinity conditions, and 90% confidence limits for salinity and (by inference) for flows.

Conclusion

Thank you for your helpful comments in this process and pointing out a number of discrepancies in the text, tables and figures contained in the draft document. We agree with your recommendation that we need to add a stand alone section identifying potential impacts to the downstream estuary. Comments on the need to reevaluate our soil salinity sampling methods and locations was also welcome. You have also made us aware of a number of assumptions contained in the report that need to clarified and that, if left unresolved, could ultimately reduce our ability to adequately protect this unique and valuable river. As you may be aware, we are in the process of upgrading hydrodynamic/salinity model to a 3-dimensional version and are collecting extensive synoptic flow and salinity data throughout this basin that we feel will provide the necessary information to address these issues in greater detail.

The MFL proposed in the draft document is intended to be an interim management target based on best available data. We envision the establishment of MFLs for the Loxahatchee River as an iterative process. Projects are already underway to meet the proposed flow of 35 cfs 94% of the time by 2006 and continue beyond that value to provide flows of 65 cfs 99% of the time by 2018. Studies are also underway to examine opportunities to enhance flows from other tributaries – Cypress Creek, Hobe Groves Ditch and Kitching Creek. The SFWMD is initiating studies with FDEP and other agencies to define overall restoration goals for the river that will not only include minimum flow criteria for the river but will also address needs for sustained average flows and periodic high flow periods that are needed to maintain a healthy river and floodplain and downstream estuary. It is anticipated that once the restoration goals for the river have been established in terms of desired flow and ecological conditions, that the MFL criteria will also have to be revised in order to be consistent with protection of the restored ecosystem from significant harm.

Review of "Technical documentation to support development of minimum flows and levels for the Loxahatchee River and Estuary"
SFWMD Water Supply Division, July 15 2002 Draft
Submitted by: Merryl Alber, Dept. of Marine Sciences, University of Georgia

Summary

The MFL proposed for the Loxahatchee River and Estuary is designed to provide adequate flow to the Northwest Fork of the River to protect the floodplain swamp community. Flow recommendations were obtained as follows: 1) a 2-d hydrodynamic model was developed that relates current flow conditions to salinity, 2) historic flows over the Lainhart Dam (1971-2000) were used in the model to hindcast daily average salinities at various places in the estuary, and the predicted salinity records were evaluated to determine both the frequency and duration of events when the water at each location was greater than various thresholds (e.g. 2 ppt), 3) a survey of the floodplain swamp community was conducted along the river, a subset of six trees were chosen as valued ecosystem components, and both the presence/absence of these trees along the river as well as their characteristics were used to identify healthy, stressed, and significantly harmed locations (at RM 10.2, 9.7, and 9.2, respectively), and finally 4) an MFL of 35 cfs at the Lainhart Dam was chosen (not to be exceeded for more than 20 d more frequently than once every 6 y), based on the model predictions of flow and salinity at the identified locations, with the goal of preventing damage or stress from occurring to the floodplain swamp community at RM 10.2 as well as preventing significant harm from occurring at RM 9.2. Additional information on soil salinity along the river, changes in vegetation over time, the relationship between flow and observed salinity, and estimates of consumptive use are also included in the document, but this information was not used directly in selecting the proposed MFL.

It is clear that the staff of the SFWMD has put a large amount of effort into the proposed MFL, and this is in many ways an improvement over the previous draft document. The report does an excellent job of addressing the comments provided in 2001, the literature review is improved, and the document is better organized. I think the shift away from cypress as an indicator is warranted, and the selected freshwater tree species provide a reasonable basis for discerning differences in the health of the floodplain community along the salinity gradient. However, there are some fundamental problems associated with the application and interpretation of the hydrodynamic model, and I do not think the document as it now stands adequately supports the proposed MFL. Below I review the major components of the proposed MFL as organized in Chapter 5.

Conclusions

Literature Review.

This is much improved over the previous version, in particular because there has been a clear effort to locate information on the salinity tolerances of cypress. However, the document would benefit from more information on the life history characteristics, functional roles, and salinity tolerances of the 6 chosen indicator species.

VEC Approach.

I'm not sure this is actually an application of the VEC approach. There is a complete list of resource functions and services provided in the document, but they are not tied very well to the floodplain swamp community. Instead, the trees that were identified are useful as indicators, rather than particularly "valued." The document indicates that these species were chosen because they occupy different ecological niches and have different functional roles, but this is not well documented. The species chosen are all relatively long-lived, and it seems like including some herbaceous species with shorter life spans is perhaps worth considering as they might provide faster response times and a better cross-section of the community.

Historical flow and salinity data

The historical flow data is presented as a very long table in Appendix D, without comment. One concern I have is whether these data were all corrected, based on the recalibration that occurred recently (this goes for Tables 23 and 24 and Figure 20 in the text as well). Although I understand that flows at G-92 are correlated with those over the Dam, they're not the same, are they? If they are, this should be stated. If not, the document would benefit from a presentation similar to that in Figure 19 of flow over the Dam since that is what is being regulated. Table 24 and Figure 20 are useful, but it would be instructive to see some summary data (e.g. different percentile flows) for the period from the reference year (1985, if that is selected) to the present.

The salinity data presented in the document are interesting. One suggestion is to recalculate the information in the Wild and Scenic segment of the river without station 63 to determine if average salinities have in fact increased over the past decade (as referred to on p. 102). This is an important point: elsewhere in the document the data suggest that flow has increased over the past decade and it would be very useful to know whether this change in flow has resulted in a measurable change in salinity or whether increased flow over the Dam has been offset by other changes in the watershed.

The salinity data presented in Appendix D were used to calibrate the hydrodynamic model, but the empirical relationships between salinity and flow were not used in any way in this document. I think these relationships are extremely useful (particularly those derived for current conditions, after the gaps had been closed) and might be appropriate as either a check on modeled salinity/flow relationships or as the basis for setting an MFL (see below). The original relationships, which were computed using Excel, are presented in figures D3-D6. These are very poor fits, and, in response to my comments on last year's document, they have been redone in SAS using variable flow-averaging periods (pages D11 – D22). The SAS fits are much improved over the ones done in Excel and could be very useful. Curiously, the SAS analysis is not referred to anywhere in the text, and SAS analyses were not performed for stations 66 and 67.

Aerial photography/GIS

This was a straightforward, complete analysis of vegetation types in the estuary over time. However, I find it worrisome that no major changes in vegetation cover were observed between 1985 and 1995. The footnote in table B-4 indicates that vegetation in a segment of the river below Trapper Nelson's was estimated from 1995 photographs. Could this substitution have perhaps led to the erroneous conclusion that things did not change in this area? Given the improvements in G-92 and the resultant increase in flow that occurred in 1989, was there a concurrent decrease in salinity (as mentioned above)? If there was an increase in salinity, wouldn't we expect to see a downstream shift in the indicator community? Perhaps this is the explanation for the field observations reported on p. 132 that suggests the location of the stressed area has moved downstream between 1985 and 1995? This needs to be explored. If there has been increased flow and decreased salinity, which in turn has led to a shift in tree distribution, that would be good evidence that the indicators are in fact appropriate. It might also mean, however, that the choice of 1985 as a reference year would result in managing towards a situation with less freshwater inflow than occurs now.

Finally, when evaluating shifts in vegetation it is worth keeping in mind that there are other factors that could account for changes in vegetation besides changes in hydrology.

River vegetation survey

The results of the vegetation survey show a clear gradient in the distribution of the 6 chosen indicator species in the floodplain community, and, although there is not technical information in place on the salinity tolerances of the various trees over the course of their life cycles, it serves as a useful starting point for the identification of healthy, stressed, and significantly harmed locations along the Northwest Fork of the River. Although these are judgment calls, the selected locations are supported by the data in terms of observed changes in the presence of the various species and by their measured characteristics (e.g. as we move downstream, fewer VEC species are represented and those that are there are smaller, with fewer seedlings and saplings). Given the fact that these trees used to occur further downstream, it is probable that salinity is an important factor that controls their distribution. One point to note is that the trends do not level off (e.g. as we move up to RM 10.6, trees are more abundant, larger, and have more seedlings and saplings). One wonders if another station further up-river would yield even more, in which case the selection of a representative healthy site might need to be re-visited.

Soil salinity samples

The observation that chloride shows a better gradient along the river than soil salinity is most likely due the fact that salinity has a much smaller dynamic range (it is constrained between 0 and 36). This makes it a less sensitive measurement, but I do not agree with the interpretation that this suggests salinity is not retained in the soil.

Hydrodynamic/salinity model

Although the 2-d model does an adequate job of matching long-term field salinity trends, the figures in Appendix E suggest some real discrepancies between observed and modeled salinity. This is acknowledged in Appendix P (p. P-4), where it states that salinity in the upper estuary is extremely sensitive to freshwater input and points out that the majority of the freshwater input was estimated from ratios (which are quite variable in reality but are fixed in the model). I understand new surface flow stations are addressing this, but without this information, and with another large estimate of inflow from groundwater (estimated as 40 cfs in a system where 35 cfs from the Dam is being proposed as the MFL), predicted salinities in the upper estuary are extremely suspect. The model may be a useful tool for exploring different management scenarios, but I am concerned about the over-reliance on model predictions of salinity as the basis of the proposed MFL.

It is instructive to compare the flows/salinities predicted by the model with those derived from the analysis presented in Appendix D: according to the model, the flow required to maintain a high tide salinity of 2 at RM 8.6 is 54 cfs (obtained from Table 7 on p. E-18), whereas an average bottom salinity of 2 ppt is correlated with a flow of 64 cfs (p. D21). At RM 7.7, the model flow is 89 cfs (again to maintain a salinity of 2). This matches the Excel fit quite well, but the prediction from the SAS relationship is approximately 140 cfs (p. D18). This suggests that **the model may underestimate the flow required to maintain salinities at their target levels and/or underestimate salinities at any point in the river, which would result in an inaccurate MFL**. If the intent is to link flow and salinity it would be more defensible (and simpler) to stick with the empirical relationships derived in Appendix D.

Even if the model were judged as the most appropriate tool for predicting salinity at different locations in the river under different flow conditions, it makes no sense to use a flow/salinity model calibrated with current data to predict 30 years worth of salinity. First, the document makes clear that there have been extensive changes in both the watershed and the estuary over that time period, such as dredging in the estuary, changes in land use resulting in changes in the amount of overland runoff and groundwater infiltration, and closing the “gaps” (which added 0.7 miles to the river). All of these changes could affect flow/salinity relationships, making historic salinity predictions based on current relationships less accurate. At the very least, some of the model predictions could be compared to historic salinity data (e.g. Appendix A describes studies by Chiu (1975), Hill (1977), Russell and McPherson (1974), and Law Environmental (1991), all of which collected salinity information).

Second, even if it could be demonstrated that the model can in fact be used to predict historic salinities, flow conditions have changed over the 30-year time period: The G-92 structure was not constructed until 1974, its capacity was increased in 1986 and additional culverts and operational criteria were added in 1987. In fact, the document states that flow over the Lainhart Dam averaged 52 cfs from 1977-1989 and increased to 86 cfs from 1990-2001, and that the occurrence of flows below 35 cfs decreased from 34% of the time to 25% of the time between the two time periods. This means that salinities at given locations in the river were very possibly greater before 1987 than they are today (this could be verified by comparing some of the field observations). Moreover, the reference point chosen by the SFWMD as the basis for establishing an MFL is 1985. It therefore does not make sense to look back to 1970.

All of the problems stated above mean that using a 30-year record to determine salinities (and deriving statistics about the average amount of time salinities at different sites are greater than a particular threshold) is not useful for understanding current conditions or setting MFLs. That said, the Ds/Db ratio is extremely interesting and looks like a useful approach for summarizing salinity data. Perhaps it could be used to characterize field salinity observations (e.g. between 1997 and 2000).

<u>Vegetation/Salinity model</u>

The MFL was chosen based on the model-predicted salinities at the locations identified in the vegetation surveys as healthy, stressed, and significantly harmed. To begin with, the goal of the MFL is not clear: if RM 9.2 has already been identified as an area that is experiencing significant harm (over what time frame?), then it makes no sense that the flow target has been chosen to prevent significant harm from occurring there (as stated on p. v and p. 149). The time frame is also not clear. On p. C-16 it suggests that long-term average salinity conditions since

1970 have led to the decline in freshwater vegetation, yet the analysis in Chapter 5 suggests that using those long-term averages is an appropriate basis for protecting the resource from further harm. Once the baseline condition gets sorted out (is it 1985? and has flow, salinity, or floodplain changed since that time?), this needs to be revisited.

If current vegetation at RM 10.2 is deemed healthy and the MFL goal is to protect it from harm, then what is required is to provide as much flow to RM 10.2 as it currently gets (i.e. the status quo). If this is the case, it would be much more straightforward to analyze the flow record over an appropriate period (e.g. since 1985, or perhaps since G-92 was improved or since the gaps were closed) and determine average flow (or a particular percentile flow, or the proportion of time that flow falls below a particular percentile). Interestingly, the report states that average flow over the Dam was 70 cfs from 1971-2001 (p. 160). In comparison, the model results presented in Table 40 suggest that 50 cfs is required to maintain average historic salinities of <0.15 at RM 10.2 This again suggests that the model is underestimating flow.

If the MFL goal is to provide enough freshwater so that the salinity regime currently experienced at RM 10.2 can be reproduced at a downstream location (e.g. RM 9.7 or 9.2), then it becomes necessary to understand the relationship between flow and salinity, and this is where the model comes in. However, even if the model were appropriate and could be used to predict salinities at these river locations, I find the logic here extremely convoluted. What is essentially happening is that a) the model begins with a relationship between salinity and flow, b) historic flow data are used to predict historic salinity, c) historic salinity data are used to determine Ds and Db, d) Ds and Db are related back to flow, when all that is really needed is the relationship between salinity and flow.

Moreover, when I followed the data in order to do a "reality check" on the model, things did not add up: Table 24 reports that flows of less than 35 cfs at the occurred 25% of the time at the Lainhart Dam between 1990 and 2001, and 35% of the time between 1971 and 1989 (for an average event duration of 15 or 24 d with a return frequency of approximately 2 mo). In Table 37 the model predicts that a flow of 35 cfs will result in a salinity of 2 ppt at RM 9.2 (the basis of the proposed MFL standard), and in Tables 35 and 36 we see that model-predicted salinities of 2 ppt occurred on average for 46 d every 6.8 mo, or 18% of the time at RM 9.2. I recognize that there is a response time built into the model and that we cannot expect a 1:1 correlation between flow and salinity, but these estimates of Ds (46 d), Db (6.8 mo), and % time over the threshold (18%) are very different than the flow observations (15-24 d, 2 mo, and 25-35%, respectively). Likewise, flows of 10 cfs occurred 7% of the time in the data presented for the dam (an average of 19 d every 9 mo). However, at 10 cfs the model predicts a salinity of 2 ppt at RM 10.2, which is estimated to have occurred only 1% of the time (an average of 22 d every 6 y, which is also used in the proposed MFL). Either I've misinterpreted these results or the model does a very poor job of estimating these parameters and should not be used to select an MFL.

I would suggest either working with the empirical relationships derived in Appendix D that relate flow to salinity or improving the model so that it does a better job of reproducing observed salinities. In either case, it seems like the historic salinity information is not relevant and the MFL can be set based on the current salinity regimes (e.g. it would be possible to determine what flows would be necessary to change salinity conditions at RM 9.2 such that they mimic what is currently observed at RM 10.2).

Finally, I'm not sure I understand why the emphasis is on 2 ppt. If these salinities are thought to occur very rarely (e.g. the 99th percentile), then flows could theoretically be maintained at the 98th percentile without violating the MFL. However, maintaining a salinity of 1.9 at RM 9.2 would surely cause damage to the vegetation even further upstream in the River. Is the target actually to maintain average flows such that average salinity at RM 9.2 will be what is currently experienced at RM 10.2?

Consumptive Use Permit Analysis

I do not have Appendix I, but it looks as if this is a complete review of consumptive use. If dry season impacts are 5 cfs, this could be important when flows get low.

Recommendations

I do not think the MFL should be adopted until the following points are addressed:

1. 1985 as the base year for this analysis should be carefully considered. Part of this decision should be based on a determination of whether a) flow conditions, b) salinity observations, or c) vegetation has actually changed in the river since 1985. (Another possibility would be to use 1997 as a base year (after the gaps were closed), as this would make the flow/salinity relationships more straightforward.) Whatever the base year, all analyses of average flow, salinity, and vegetation should date consistently to that year.
2. The MFL goal should be clearly stated. Is it designed to maintain current conditions at RM 10.2 (the status quo) or improve conditions at 9.2 such that the floodplain community at that site is similar to what now occurs at 10.2? It cannot be to protect RM 9.2 from significant harm, as stated in the document, since this is already occurring. If there is a difference between management goals and MFL targets, this should also be stated. However, selecting an MFL at the 99th percentile flow is not likely to meet the goal of protecting RM 10.2. Managing for the 90th percentile might be more appropriate.
3. The hydrodynamic model as it stands now is inadequate for providing accurate flow/salinity relationships. The model needs to be improved, or the relationships developed in Appendix D (using SAS) should be used for this purpose. Only relationships based on current salinity conditions (after the gaps were closed) should be used, and there should be no attempt to use historic salinities for this purpose.
4. If it makes more sense to determine the MFL in terms of salinity than flow, the analysis of Ds and Db should be done based on empirical observations of salinity at each site.

Other Comments:

1. I assume it was a policy decision to limit this MFL to the Northwest Fork of the Loxahatchee. The document is uneven in this regard, since so much information is presented on the other tributaries. However, it is informative and serves as an important reference for the whole Estuary.

2. Since there's no control over the flows in the other creeks in the Northwest Fork (and since they occur downstream of RM 9.2), maintaining the floodplain community at RM 9.2 may not

help the entire estuary. This means that it might be appropriate to add additional indicators in locations further downstream.

3. I applaud the District's efforts to incorporate an adaptive management component in this effort. The proposed work on monitoring tributary/creek flows, the groundwater investigations, continued salinity monitoring and vegetation sampling should all provide useful information that can work to improve the MFL criteria.

4. The document could benefit from some careful editing to reduce redundancies.

Specific comments:

p. 44 - Please clarify whether the information in Figure 10 (and the discussion of the figure) is a presentation of allocation or actual water use.

p. 64 – What are the units for the contour lines?

p. 80 – I think the reference to Tables 15 and 16 is supposed to be Tables 16 and 17.

p. 87 – The statement that the model fits the estimates presented in Appendix D needs to be reevaluated in light of the SAS-derived estimates.

p. 93 – Please add a sentence to #2 to give an indication that there's considerable variability in these proportions.

p. 115 – What is the reference point for the statement that major changes have occurred in vegetation downstream of RM 9.2?

p. 135 – All 6 plants chosen are freshwater species, so the last bullet before the summary needs to be modified.

The statement that a healthy floodplain community exists to RM 9.8 is not substantiated by the observations, since there is no data and RM 9.7 shows fewer, smaller trees as compared to RM 10.2

p. 142 – It would aid in the interpretation of Table 38 if somewhere in the document or Appendix the locations where each of the parameters for each species is considered to be in decline were identified.

p. 145 - Why don't the criteria used in the top of Table 40 match the observations reported for RM 10.2 in Tables 35 and 36. The observations indicate that salinity at 10.2 was greater than 1 for 30 d every 1.6 y (or 5% of the time), greater than 2 for 22 d every 5.9 y (or 1% of the time), and greater than 3 ppt for 13 d every 30 y (or 0.1% of the time), and the text states that the MFL was set not to exceed 2 for more than 20 d every 6 y, in keeping with these observations. However, the criteria developed in Table 40 are for salinities greater than 1 ppt for 40 d/y, 2 ppt for 30 d/4 y and 3 ppt for 20 d/10y, which represent 10%, 2%, and 0.5% of the time, respectively.

Presumably, this means that the flows reported in the table are greater than they should be if the goal is to match the observed flow regime at RM 10.2.

p. 148 - Does the statement about providing flows comparable to historic rates represent a management target as opposed to an MFL? Which historic flows are meant here (given that flows in 1971-1989 are considerably lower than subsequent flow).

p. 153 - Is the second management target meant to describe the situation at RM 9.2 or 9.7? This should be stated.

p. 155 - How might repairs to the Dam affect the calibration of flow? If there are major leaks now, this could also affect flow/salinity relationships.

p. 160 - The information discussed here cannot be found in Table 5.

Appendix A had figures missing.

Appendix B: Isn't this supposed to be a comparison of 2 interpretations of vegetation from 1940? This is not clear.

Appendix C. It is difficult to follow the analysis of Ds/Db presented in Table C-4 without the information presented in Tables 30-32, 36, and 39. The document would benefit if the information presented for red maple in Table 39 was presented for all species in the Appendix.

Appendix D

Appendix D describes the use of data from 1997 through 2000, yet some of the graphs begin in 1994 and others begin in 1996. It would probably be best to use the data from after the gaps were closed, as this added 0.7 miles to the channel.

SAS analyses need to be performed for stations 66 and 67.

All the Excel graphs should be deleted, since we know there are errors in the way Excel computes curve fits.

Table D-1 needs to be redone to reflect the appropriate dry season discharges derived from the SAS fits. The flow-averaging period that produces the best fit is probably the one to use (this varies from 3-d for all data to 9-d for after the closure of the gaps, which is more evidence that these relationships changed at that time). Station 65 produced the best fit on the day of observation, perhaps because it is closer to the Dam.

Once the graphs and Table D-1 have been updated, the text in this Appendix needs to be changed accordingly.

Appendix E.

I only had black and white copies of the figures and so had a lot of difficulty interpreting them.

I do not understand the paragraph on p. E-18 that describes Figures 12-15.

Appendix H states that the salinity data set was estimated based on flow relationships developed in Appendix D, but as far as I can tell these empirical relationships were not used.

Appendix N had figures missing.

SFWMD Draft Response to Peer Review Comments of Dr. Merryl Alber, Ph.D. for the July 2002 Draft Loxahatchee River MFL Technical Documents

The following are initial *draft* peer review comments prepared by SFWMD staff. District staff are reviewing these comments and are in the process of supplying additional information requested by some panel members. As a result, some of these peer comments and District responses may change after consideration of supplemental information. Final peer review comments will be posted once they are received.

The following comments were submitted in support of the methods, approach, and documentation of the proposed MFL:

- "*…It is clear that the staff of the SFWMD has put a large amount of effort into the proposed MFL, and this is in many ways an improvement over the previous draft document. The report does an excellent job of addressing the comments provided in 2001, the literature review is improved, and the document is better organized. I think the shift away from cypress as an indicator is warranted, and the selected freshwater tree species provide a reasonable basis for discerning differences in the health of the floodplain community along the salinity gradient…*"

- "*…This [the literature review] is much improved over the previous version, in particular because there has been a clear effort to locate information on the salinity tolerances of cypress…*"

- "*… The results of the vegetation survey show a clear gradient in the distribution of the 6 chosen indicator species in the floodplain community, and, although there is not technical information in place on the salinity tolerances of the various trees over the course of their life cycles, it serves as a useful starting point for the identification of healthy, stressed, and significantly harmed locations along the Northwest Fork of the River. Although these are judgment calls, the selected locations are supported by the data in terms of observed changes in the presence of the various species and by their measured characteristics (e.g. as we move downstream, fewer VEC species are represented and those that are there are smaller, with fewer seedlings and saplings)….*"

- "…Th*e Ds/Db ratio is extremely interesting and looks like a useful approach for summarizing salinity data. Perhaps it could be used to characterize field salinity observations (e.g. between 1997 and 2000)….*"

- "…I applaud the District's efforts to incorporate an adaptive management component in this effort. The proposed work on monitoring tributary/creek flows, the groundwater investigations, continued salinity monitoring and vegetation sampling should all provide useful information that can work to improve the MFL criteria…"

The following comments summarize Dr. Alber's concerns with the draft document

Page 1, 2nd paragraph: *"…There are some fundamental problems associated with the application and interpretation of the hydrodynamic model, and I do not think the document as it now stands adequately supports the proposed MFL…."*
Page 2, 4th Paragraph: *The salinity data presented in Appendix D were used to calibrate the hydrodynamic model, but the empirical relationships between salinity and flow were not used in any way in this document. I think these relationships are extremely useful (particularly those derived for current conditions, after the gaps had been closed) and might be appropriate as either a check on modeled salinity/flow relationships or as the basis for setting an MFL (see below). The original relationships, which were computed using Excel, are presented in figures D3-D6. These are very poor fits, and, in response to my comments on last year's document, they have been redone in SAS using variable flow-averaging periods (pages D11 – D22). The SAS fits are much improved over the ones done in Excel and could be very useful. Curiously, the SAS analysis is not referred to anywhere in the text, and SAS analyses were not performed for stations 66 and 67.*

- **District Response**: We agree with the reviewer's comment that the document needs to include a section in the Appendix that discusses the empirical relationships generated by Excel and SAS as presented in the report and how these relationships compare with the hydrodynamic model output (also see the following responses below).

Page 3, 5th Paragraph: *Although the 2-d model does an adequate job of matching long-term field salinity trends, the figures in Appendix E suggest some real discrepancies between observed and modeled salinity. This is acknowledged in Appendix P (p. P-4), where it states that salinity in the upper estuary is extremely sensitive to freshwater input and points out that the majority of the freshwater input was estimated from ratios (which are quite variable in reality but are fixed in the model). I understand new surface flow stations are addressing this, but without this information, and with another large estimate of inflow from groundwater (estimated as 40 cfs in a system where 35 cfs from the Dam is being proposed as the MFL), predicted salinities in the upper estuary are extremely suspect. The model may be a useful tool for exploring different management scenarios, but I am concerned about the over-reliance on model predictions of salinity as the basis of the proposed MFL*

- **District Response**: The reviewer was not supplied with color copies of the graphics presented in Appendix P and therefore it was not clear that (a) the model tended to follow the same pattern of daily salinity change as shown by the field data and (b) the model also tends to more closely predict field data at the more upstream sites where the vegetation communities of concern are located. Color copies of Appendix P have since been provided to Dr. Alber for review.

  District staff also looked at flow ratios calculated from measured data obtained from the Lainhart Dam and the other three tributaries under various average and low flow rainfall periods and compared these values to those used in the model. In general, the flow ratios used in the model were comparable to field measurements recorded during low rainfall periods, the period of time of most concern. For example, in the model the Lainhart Dam represents 44% of the total flow delivered to the NW Fork during the dry season as compared to inflows from the three other tributaries. Field measurements show this ratio to be 45% for data collected from the 1980-81 drought dry season, 46% from the 1980-81 drought wet season, 40% from the 1989-90 drought dry season, and 56% from the 1989-

90 drought wet season. Flow data is not available from Hobe Grove Ditch and Cypress Creek after 1994 as these gages were damaged after a major storm and were not replaced.

The estimate of groundwater flow was derived from a comparison of field data derived from a 1983 USGS report and measured flow/salinity data collected from a dry period in May 1999. The District recognizes that more groundwater data flow data would be desirable to confirm the estimate used in the model, but the 40 cfs value currently represents "best available data". We have no evidence to suggest that overall regional groundwater levels have changed within the basin since 1985, the period of time when the river was first designated as a Wild & Scenic River, to affect this rate.

The hydrodynamic/salinity model currently represents the District's best available tool for determining the complex interactions between daily tributary inflows and daily tidal fluctuations within the river, including variations resulting from the effects of lunar and solar cycles (e.g. spring or neap tides) and "lags" in the movement of salinity up/down the channel between tidal maxima.

Page 4, 1st Paragraph: *It is instructive to compare the flows/salinities predicted by the model with those derived from the analysis presented in Appendix D: according to the model, the flow required to maintain a high tide salinity of 2 at RM 8.6 is 54 cfs (obtained from Table 7 on p. E-18), whereas an average bottom salinity of 2 ppt is correlated with a flow of 64 cfs (p. D21). At RM 7.7, the model flow is 89 cfs (again to maintain a salinity of 2). This matches the Excel fit quite well, but the prediction from the SAS relationship is approximately 140 cfs (p. D18). This suggests that the model may underestimate the flow required to maintain salinities at their target levels and/or underestimate salinities at any point in the river, which would result in an inaccurate MFL. If the intent is to link flow and salinity it would be more defensible (and simpler) to stick with the empirical relationships derived in Appendix D.*

- **District Staff's Response**: The review has identified the need for District staff to conduct additional analysis that compare model results with available field data. These additional analysis are needed to give the reader greater assurance that the model results compare favorably with observed data, and that use of the hydrodynamic/salinity model represents the best tool available to establish flow/salinity relationships within the NW Fork of the river. To that end, District staff will conduct additional analysis and provide language in Appendix D and in the results section of the report that compare modeled data versus existing field information. This section of the document will also discuss the technical reasons and rationale as to why the District selected the hydrodynamic/salinity model as the best tool available for determining long-term flow salinity relationships.

  A review of the data presented in Appendix D noted a number of discrepancies between results provide by the SAS analysis and the results provided by the Excel analysis. For the reasons noted during the first peer review, we did not favor use of the Excel data. However, when we examined the data produced by SAS, we also noted some significant discrepancies. For example in the upper figure on page D-18, approximately 7 data points in the range from 100 to 150 cfs are above the SAS-predicted curve and more than 30 data points lie below this curve. This suggests (to us) that the SAS relationship may be over-predicting the amount of flow required for given level of salinity in this flow range. This was one of several reasons, we decided not to use either of the statistical relationships and use the model instead. That is why the new version of the document did not include reference to either statistical approaches. Again, we agree the document needs to provide a discussion comparing the empirical relationships presented in Appendix D as compared to the model output and why the model was chosen as the tool of choice for this analysis.

<u>Page 4, 2nd Paragraph</u>: *Even if the model were judged as the most appropriate tool for predicting salinity at different locations in the river under different flow conditions, it makes no sense to use a flow/salinity model calibrated with current data to predict 30 years worth of salinity. First, the document makes clear that there have been extensive changes in both the watershed and the estuary over that time period, such as dredging in the estuary, changes in land use resulting in changes in the amount of overland runoff and groundwater infiltration, and closing the "gaps" (which added 0.7 miles to the river). All of these changes could affect flow/salinity relationships, making historic salinity predictions based on current relationships less accurate. At the very least, some of the model predictions could be compared to historic salinity data (e.g. Appendix A describes studies by Chiu (1975), Hill (1977), Russell and McPherson (1974), and Law Environmental (1991), all of which collected salinity information).*

<u>Page 4, 3rd Paragraph</u>: *Second, even if it could be demonstrated that the model can in fact be used to predict historic salinities, flow conditions have changed over the 30-year time period: The G-92 structure was not constructed until 1974, its capacity was increased in 1986 and additional culverts and operational criteria were added in 1987. In fact, the document states that flow over the Lainhart Dam averaged 52 cfs from 1977-1989 and increased to 86 cfs from 1990-2001, and that the occurrence of flows below 35 cfs decreased from 34% of the time to 25% of the time between the two time periods. This means that salinities at given locations in the river were very possibly greater before 1987 than they are today (this could be verified by comparing some of the field observations). Moreover, the reference point chosen by the SFWMD as the basis for establishing an MFL is 1985. It therefore does not make sense to look back to 1970.*

All of the problems stated above mean that using a 30-year record to determine salinities (and deriving statistics about the average amount of time salinities at different sites are greater than a particular threshold) is not useful for understanding current conditions or setting MFLs. That said, the Ds/Db ratio is extremely interesting and looks like a useful approach for summarizing salinity data. Perhaps it could be used to characterize field salinity observations (e.g. between 1997 and 2000).

- **<u>District Staff's Response</u>**: Some of the information provided in the document suggests that watershed storage and drainage patterns have changed significantly within the basin over the past 30 years. It is true that over the past 10 years significantly more flow has been directed to the NW Fork via G-92 and the Lainhart Dam during normal and above normal rainfall conditions. This is due to increased rainfall experienced over the past 10 years as well as improvements made to G-92 which can now direct more water from the Loxahatchee Slough to the river (when it is available). However, our understanding of the watershed indicates that overall storage within the basin has remained unchanged since construction of C-18 in 1957-58. This means that during dry periods only a certain amount of water can be stored in the basin due to its limited water storage capacity. As a result, the amount of water directed towards the NW Fork during dry periods in the 1990s, is comparable to dry season flows that were recorded during the 1970s and 1980s which is precisely the problem that the MFL is trying to address. Because the basin has a limited water storage capacity, dry season flows delivered to the river have not changed significantly over time. Therefore, we believe it was reasonable to use current flow/salinity data relationships to predict past salinity events. **Table 1** provides a summary of these relationships based on flow/duration curves developed for Lainhart Dam data from different time periods. As shown in **Table 1** the amount of flow directed towards the river during high and normal rainfall periods (10th, 25th and 50th percentiles) has increased between 1985-1989 and 1990-2001, however the amount of water available for delivery to the river during low rainfall or drought periods (75th & 90th percentiles) has not increased much between 1985-1989 and the 1990-2001.

Table 1. Percent of time flows were equaled or exceeded at the Lainhart Dam

	Percent time of Lainhart Dam flows were equal to or exceeded (values reported in cfs)				
Period of record	10%	25%	50%	75%	90%
1971-2001 all data	173	105	60	29	14
1971-1984	120	90	51	25	14
1985 - 1989	116	90	59	31	16
1990-2001	226	152	82	35	14

* Data obtained from Flow duration curves

The primary purpose for developing a 30 year salinity history for the river was two fold. First it was necessary to provide a means for representing historical salinity conditions that have impacted the river over time. Secondly we needed a 30 year salinity record to capture the interannual variability of rainfall patterns that have occurred within the basin to help determine a return frequency for the occurrence of natural low flow periods that could be incorporated into the MFL criteria.

As you point out, we are implementing an adaptive assessment approach to our future research and monitoring efforts. Our ongoing flow/salinity monitoring program with the USGS has been enhanced through the placement of additional continuous flow and salinity monitoring stations. These additional data will help to address a number of the technical uncertainties associated with the model predictions. These new data should indicate the degree to which our proposed MFL will achieve the desired salinity conditions. If monitoring results show that the proposed flows are not sufficient, they will be subsequently modified as needed to protect the resource from significant harm. As stated in the our MFL Recovery Plan, a number of major projects are underway to provide more flow to the river – to achieve a sustained flow of 35 cfs or greater by 2006 and a flow of 65 cfs or greater by 2018.

Page 2, 2nd Paragraph: *The historical flow data is presented as a very long table in Appendix D, without comment. One concern I have is whether these data were all corrected, based on the recalibration that occurred recently (this goes for Tables 23 and 24 and Figure 20 in the text as well). Although I understand that flows at G-92 are correlated with those over the Dam, they're not the same, are they? If they are, this should be stated. If not, the document would benefit from a presentation similar to that in Figure 19 of flow over the Dam since that is what is being regulated. Table 24 and Figure 20 are useful, but it would be instructive to see some summary data (e.g. different percentile flows) for the period from the reference year (1985, if that is selected) to the present.*

- **District Staff's Response**: We have presented an analysis of the flow data from Lainhart Dam in Appendix H, but as you have pointed out, we have not included a discussion of source, re-calibration history, etc. In addition, we agree with the reviewer that a historical analysis and re-calibration history should be clearly presented in the main body of the report. We will also include a clear explanation of how G-92 and Lainhart Dam flows are linked together, but are not the same. This oversight will be corrected in the final draft of the technical document. The suggestion that a figure for Lainhart Dam flows, similar to Figure 19 for the G-92 structure, is well taken.

Page 1, 3rd Paragraph: *This [literature review section] is much improved over the previous version, in particular because there has been a clear effort to locate information on the salinity tolerances of cypress. However, the document would benefit from more information on the life history characteristics, functional roles, and salinity tolerances of the 6 chosen indicator species.*

- **District Staff's Response**: Comments noted.

Page 2, 1st Paragraph: *I'm not sure this is actually an application of the VEC approach. There is a complete list of resource functions and services provided in the document, but they are not tied very well to the floodplain swamp community. Instead, the trees that were identified are useful as indicators, rather than particularly "valued." The document indicates that these species were chosen because they occupy different ecological niches and have different functional roles, but this is not well documented. The species chosen are all relatively long-lived, and it seems like including some herbaceous species with shorter life spans is perhaps worth considering as they might provide faster response times and a better cross-section of the community.*

- **District Staff's Response**: The group of species identified as indicators collectively form part of a "valued ecosystem component", namely the freshwater forest canopy. These species are part of a multi-level high forest canopy that provides a specialized habitat upon which many species depend. A description of the function of this forest component can be found in Appendix C, page C-20. It is this group of six floodplain forest species that is the target VEC, rather than a single indicator species as is often the case. We can try to clarify that concept in the final draft of the document, as it may not be sufficiently clear as written in this section.

  Because we were trying to relate long-term salinity conditions to impacts to the freshwater community, long-lived species were selected. This reflects our commitment to determining the potential deleterious effects of chronic exposure that may not show up until long after the effects of acute exposure have passed. Available studies of shorter-lived species and short-term response times (acute exposure effects) are presented in the literature review section. However, the suggestion that there is value in also considering the response of shorter-lived species with faster response times is well taken and we are moving towards identifying those candidates through a contract with a consultant. We realize that understanding both the short term and long-term impacts of salinity exposure to the freshwater community are important. A discussion of short-term versus long-term exposure (i.e. chronic versus acute) can be found in Appendix C, page C-18. We can further address this issue in the final draft of the technical document.

Page 2, 3rd Paragraph: *The salinity data presented in the document are interesting. One suggestion is to recalculate the information in the Wild and Scenic segment of the river without station 63 to determine if average salinities have in fact increased over the past decade (as referred to on p. 102). This is an important point: elsewhere in the document the data suggest that flow has increased over the past decade and it would be very useful to know whether this change in flow has resulted in a measurable change in salinity or whether increased flow over the Dam has been offset by other changes in the watershed.*

- **<u>District Staff's Response</u>**: Comments noted; we will provide a description of the SAS analysis and show how these results compare to the modeled output.

<u>Page 2, 5th Paragraph</u>: *This was a straightforward, complete analysis of vegetation types in the estuary over time. However, I find it worrisome that no major changes in vegetation cover were observed between 1985 and 1995. The footnote in table B-4 indicates that vegetation in a segment of the river below Trapper Nelson's was estimated from 1995 photographs. Could this substitution have perhaps led to the erroneous conclusion that things did not change in this area? Given the improvements in G-92 and the resultant increase in flow that occurred in 1989, was there a concurrent decrease in salinity (as mentioned above)? If there were an increase in salinity, wouldn't we expect to see a downstream shift in the indicator community? Perhaps this is the explanation for the field observations reported on p. 132 that suggests the location of the stressed area has moved downstream between 1985 and 1995? This needs to be explored. If there has been increased flow and decreased salinity, which in turn has led to a shift in tree distribution, that would be good evidence that the indicators are in fact appropriate. It might also mean, however, that the choice of 1985 as a reference year would result in managing towards a situation with less freshwater inflow than occurs now. Finally, when evaluating shifts in vegetation it is worth keeping in mind that there are other factors that could account for changes in vegetation besides changes in hydrology.*

- **<u>District Staff's Response</u>**: The referenced footnote in Table B-4 should have read "…a segment of the river ***<u>upstream of</u>*** Trapper Nelson's were estimated…". As written, it could be confused with indicating an area downstream of Trapper Nelson's, which is not the case. Because the areas upstream of Trapper Nelson's have remained essentially unchanged from historical conditions (e.g. 1940 reference aerial photo), this estimate is not particularly relevant to documenting change on the NW Fork relative to salinity exposure. Hence, our comparison of 1985 and 1995 aerial photos remains complete for the areas of interest (i.e. the NW Fork downstream of Trapper Nelson's).

  It was noted although perhaps not clearly in this section of the document, that even though flows to the NW Fork have increased with the improvements to G-92, the duration of low flow events has not significantly changed (see Table 24). It is during these periods that potential damage to the freshwater community can result from salinity intrusion. So, even though flows have improved, the benefit is mostly during average and high flow times.

  The discrepancy between the location of the "stressed" area mentioned in the 1984 EIS and the District's vegetation survey in 2002 may be attributed to the fact that the location of the transition zone in the EIS was based upon qualitative, subjective, visual accounts. The location of the transition zone from "healthy" to "stressed" communities in the 2002 vegetation survey was founded on measured field data. Because the location of the beginning of the stressed zone in the EIS was not founded on measured field data, it is not possible to re-survey field sites for comparison of 1985 and 2002 time frames. Hence, comparison between the two remains more of a presentation of what is known to have been recorded in past documents with what has been found in current studies.

  In order to address the possibility that other factors may be involved in the observed changes in vegetation along the NW Fork, a discussion was included in Appendix C, page C-17.

<u>Page 3, 3rd Paragraph</u>: *The results of the vegetation survey show a clear gradient in the distribution of the 6 chosen indicator species in the floodplain community, and, although there is not technical information in place on the salinity tolerances of the various trees over the course of their life cycles, it serves as a useful starting point for the identification of healthy, stressed, and significantly harmed locations along the Northwest Fork of the River. Although these are judgment calls, the selected locations are supported by the data in terms of observed changes in the presence of the various species and by their measured characteristics (e.g. as we move downstream, fewer VEC species are represented and those that are there are smaller, with fewer seedlings and saplings). Given the fact that these trees used to occur further downstream, it is probable that salinity is an important factor that controls their distribution. One point to note is that the trends do not level off (e.g. as we move up to RM 10.6, trees are more abundant, larger, and have more seedlings and saplings). One wonders if another station further up-river would yield even more, in which case the selection of a representative healthy site might need to be re-visited.*

- **<u>District Staff's Response</u>**: The observation that some of the vegetation trends did not "level off" is noted. Above the Trapper Nelson site (approximately river mile 10.6), the river's character changes significantly. The river narrows substantially, becoming more stream-like, and is entirely covered by the forest canopy. Downstream of Trapper Nelson's, the channel widens and the river distinctly splits the forest canopy, resulting in a shoreline vegetation ecotone that is not found upstream. All vegetation surveys were conducted in this area. For this reason, a comparison of vegetation data from sites upstream of Trapper Nelson's with sites downstream of there would not be consistent or recommended.

<u>Page 3, 4th Paragraph</u>: *The observation that chloride shows a better gradient along the river than soil salinity is most likely due the fact that salinity has a much smaller dynamic range (it is constrained between 0 and 36). This makes it a less sensitive measurement, but I do not agree with the interpretation that this suggests salinity is not retained in the soil.*

- **<u>District Staff's Response</u>**: Comment noted.

<u>Page 4, 5th Paragraph</u>: *The MFL was chosen based on the model-predicted salinities at the locations identified in the vegetation surveys as healthy, stressed, and significantly harmed. To begin with, the goal of the MFL is not clear: if RM 9.2 has already been identified as an area that is experiencing significant harm (over what time frame?), then it makes no sense that the flow target has been chosen to prevent significant harm from occurring there (as stated on p. v and p. 149). The time frame is also not clear. On p. C-16 it suggests that long-term average salinity conditions since 1970 have led to the decline in freshwater vegetation, yet the analysis in Chapter 5 suggests that using those long-term averages is an appropriate basis for protecting the resource from further harm. Once the baseline condition gets sorted out (is it 1985? and has flow, salinity, or floodplain changed since that time?), this needs to be revisited.*

- **<u>District Staff's Response.</u>** Examination of historic aerial photography data indicated that hydrologic conditions from 1940 to 1985 has led to a decline in condition of the freshwater community, The condition of the resource in 1985 (when the river was designated as a Wild & Scenic River) was a reflection of this past salinity history. Changes that have occurred since that time have increased flow to the river during normal and high rainfall periods, but have not significantly improved these vegetation communities. We contend that improvements in these communities has not occurred because the river continues to experience periods of low or zero flow (see Table 1 above and Table 24 in the document) that are allowing salt water to penetrate upstream with about the same frequency as occurred historically, and that these events are preventing recovery. We are proposing, through the MFL, to greatly reduce the number of events that result in zero or low flow periods.

In addition, the goal of the MFL is to protect the identified resource from significant harm. The salinity regime identified at river mile 10.2 appears to support a healthy freshwater floodplain swamp, so that regime was applied as the maximum allowable salinity at river mile 9.2 where there still exists a remnant freshwater swamp. Hence, the proposed MFL not only protects the remaining intact community found at river mile 10.2, but also allows some recovery of remnant freshwater communities upstream of river mile 9.2.

Page 5, 2nd Paragraph: *If current vegetation at RM 10.2 is deemed healthy and the MFL goal is to protect it from harm, then what is required is to provide as much flow to RM 10.2 as it currently gets (i.e. the status quo). If this is the case, it would be much more straightforward to analyze the flow record over an appropriate period (e.g. since 1985, or perhaps since G-92 was improved or since the gaps were closed) and determine average flow (or a particular percentile flow, or the proportion of time that flow falls below a particular percentile). Interestingly, the report states that average flow over the Dam was 70 cfs from 1971-2001 (p. 160). In comparison, the model results presented in Table 40 suggest that 50 cfs is required to maintain average historic salinities of <0.15 at RM 10.2 This again suggests that the model is underestimating flow.*

- **District Staff's Response**: Average flows recorded for the river shown in Table 23 includes periods of high flow (> 1,000 cfs) as well as long periods of low or zero flow. The latter are of special concern. Under current conditions, an average flow of 70 cfs may include periods of zero flow and may not protect the resource, whereas a lower average flow of 50 cfs, with a minimum flow of not less than 35 cfs, for 20 days duration, occurring no more often than once every 6 years would better protect the resource against salt water intrusion (significant harm).
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Page 5, 3rd Paragraph: *If the MFL goal is to provide enough freshwater so that the salinity regime currently experienced at RM 10.2 can be reproduced at a downstream location (e.g. RM 9.7 or 9.2), then it becomes necessary to understand the relationship between flow and salinity, and this is where the model comes in. However, even if the model was appropriate and could be used to predict salinities at these river locations, I find the logic here extremely convoluted. What is essentially happening is that a) the model begins with a relationship between salinity and flow, b) historic flow data are used to predict historic salinity, c) historic salinity data are used to determine Ds and Db, d) Ds and Db are related back to flow, when all that is really needed is the relationship between salinity and flow.*

- **District Staff's Response**: The goal of the MFL is to protect the resource from significant harm and providing sufficient freshwater flow is one means of doing so. In addition to understanding the relationship between flow and salinity, it is also important to understand the relationship between salinity and harm to the resource. Because of a lack of suitable long-term salinity data for multiple sites along the NW Fork, a model was used to generate a long-term salinity daily time series that would provide reasonable estimates of the long-term salinity history at upstream locations. Ds and Db, a summary of this generated salinity time series, was used to relate changes to freshwater vegetation (the identified resource to be protected) with salinity. This analysis was carried out by request of the 2001 Peer Review Panel's recommendations.

Page 5, 4th Paragraph: *Moreover, when I followed the data in order to do a "reality check" on the model, things did not add up: Table 24 reports that flows of less than 35 cfs at the occurred 25% of the time at the Lainhart Dam between 1990 and 2001, and 35% of the time between 1971 and 1989 (for an average event duration of 15 or 24 d with a return frequency of approximately 2 mo). In Table 37 the model predicts that a flow of 35 cfs will result in a salinity of 2 ppt at RM 9.2 (the basis of the proposed MFL standard), and in Tables 35 and 36 we see that model-predicted salinities of 2 ppt occurred on average for 46 d every 6.8 mo., or 18% of the time at RM 9.2. I recognize that there is a response time built into the model and that we cannot expect a 1:1 correlation between flow and salinity, but these estimates of Ds (46 d), Db (6.8 mo), and % time over the threshold (18%) are very different than the flow observations (15-24 d, 2 mo, and 25-35%, respectively). Likewise, flows of 10 cfs occurred 7% of the time in the data presented for the dam (an average of 19 d every 9 mo). However, at 10 cfs the model predicts a salinity of 2 ppt at RM 10.2, which is estimated to have occurred only 1% of the time (an average of 22 d every 6 y, which is also used in the proposed MFL). Either I've misinterpreted these results or the model does a very poor job of estimating these parameters and should not be used to select an MFL.*

- **District Staff's Response**: Your questions and concerns have required the District to take a much closer look at the details of how modeled data (daily and long-term modeling results) compare with actual measured salinity data during the calibration and verification periods. We were aware of potential discrepancies between the measured data and modeled data but felt, on the whole, that the model was providing a reasonable picture of long-term flow/salinity conditions in the river. Furthermore, because the actual record of measured data was so sporadic in time and location, use of the model was preferred, since it could be used to generate a continuous picture of conditions in the river at any desired location over a 30 years period.

  Our first step in this analysis was to look at salinity conditions for water quality station #66 as represented in Figure 21 on page E-42 in the appendices. This graphic provides a comparison between modeled versus actual measured salinity conditions in the river from May to June 1999 (at the end of the dry season) at water quality station #66, which is located at river mile 9.4, within the area that has experienced "significant harm" based on our vegetation analysis.

  Actual flow data from Lainhart Dam for May to June 1999 are provided in the table on page D-52, column 3. Flow across Lainhart Dam during this period was at or below 10 cfs during most of the month of May and the first four days of June. Flow then increased rapidly to 135 cfs by June 13 and remained high for the rest of the month. Actual salinity data (red line on Figure 21 in Appendix E) were measured sporadically during this period. Salinities were in the range from 5-7 ppt during the early part of the month but then declined from May 10 (about 240 hrs) to May 25 (600 hrs), at which point there is a break in the record. The period from 840 to 930 hours represents the period from June 4 to June 12. During this time, measured bottom salinities decline from 5 ppt to zero within one day while the modeled salinity data show a steady decline to zero over a four day period. Figure 21 also shows the long-term salinity record (solid dark line) indicating a lag time of about four days and then a decline to zero over about a period of about 5 days.

Daily salinity values produced by the model showed variations in that generally reflect freshwater flow from Lainhart Dam along with solar/lunar tidal cycles etc. Predicted salinities at station # 66 during the low-flow period in May and early June ranged from a minimum low tide low salinity of about 1 ppt (near 600 hours) to a maximum high tide high salinity of about 13 ppt (at about 48 hours).

By contrast, results of the long-term model, agrees with the almost constant discharge from the Lainhart Dam, showing a 33 day period from about 75 hours to about 900 hours when salinities were above 5 ppt. The long term model shows a 4-5 day lag when salinity conditions change in the system, which is a function of how this aspect of the model works (see the note on page E-16)

Another comparison between modeled and measured data is provided by examining the salinity vs. discharge relationship graph in Figure D-6 on page D-7 for station #66 and looking at the extreme left hand side of this graph at the distribution of salinity values for flows of zero to 5 cfs. Under these low flow conditions, salinities ranged from 0.5 to about 9.8 ppt. Without doing a formal calculation, we counted approximately 11 data points above 5 ppt and 23 or so in the range from 2 to 5 ppt. It appears as though the median salinity for zero discharge is somewhere between 4 and 5 ppt.

Overall, results of these comparisons indicate that, in the short-term, the salinity model provides estimates of salinity that are within the same range as field measurements. Differences appear to occur when some undocumented input of freshwater (such as local rainfall) is occurring that results in a lower than estimated salinity value. Such an event may have occurred between 300 and 600 hours (Figure 21, page E-42). The long-term model, which estimates a daily average and does not specifically account for lunar and solar cycles (see page E-16 and graphic example in Figure 19), but does include their values implicitly in determining an overall long-term average salinity regime. The long-term model has a smoothing effect on the data. In the example shown in Figure 21, at very low flows, the result was "constant" estimated salinity of about 5-6 ppt that is very close to the median of observed data, which was on the order of 4-5 ppt.

A more variable data record, at station 65 (river mile 8.6) is shown in Figure 20 on page E-4. This graph indicates that there are periods when the long term model appears to overestimate the salinity (e.g. 2800 to 4000 hours) and periods when it underestimates (1200 to 2400 hours). It should be noted that the "actual" salinity record during the period from 1600 to 1700 hours, ranging from 10 to 16 ppt, may be in error due equipment malfunction or transcription errors. Examination of actual flow data from the month of March (page D-52, second column) indicates that flows throughout that month were generally in the range from 30 to 50 cfs, with the exception of a four day period from March 5-8 when flows declined to 25 cfs.

If we look at the SAS relationship on page D-21 (upper graph) a flow of 25 cfs could be expected to produce a bottom salinity of about 7.5 ppt , with a range, from 0 to 13 ppt. By looking at Figure 19, we can see that this time period corresponds to a neap tide, and so the short-term model predicts a relatively lower salinity value (due to weaker tides), on the order of 1-2 ppt (on Figure 20) and the long-term model predicts a salinity in the range of 3 ppt.

The consensus based on this type of analysis was that the calibration and verification in 1999 were relatively good. However, it was apparent that each of the approaches has distinct limitations and potential sources of error or bias. The decision to use the model, as opposed to using either of the statistical relationships was based on a) the model could be used to provide a continuous set of daily, weekly, monthly values over a designated time period, that provided some consideration of known forces, such as tides, that influence salinity conditions; b) The model provided us with a better ability to interpolate and extrapolate to locations throughout the river, beyond the model boundaries and existing data sets, and in areas where available data were very limited (e.g. station 67) or non-existent; and c) the model provided a better basis for comparison of current conditions with hypothetical future conditions.

Based on consideration of how the model analyzes and interprets flow data, and the apparent discrepancies between field-measured salinities and flow across Lainhart Dam (as evidenced for example in the amount of "scatter" that exists in the graphs on pages D-6 and D-7 and pages D-15 to D-22), it is not surprising that the frequency distribution of low-flow events over Lainhart Dam presented in Table 24 on Page 98 does not match well with the frequency distribution of salinity events derived from the long-term model, as shown in Tables 34- 36 on pages 138 and 139. The fact that under current (1990 to 2001) conditions, flows drop below 35 cfs for 15 days every two months (table 24) may not be comparable to the prediction that salinities will exceed 2ppt for 46 days every 6. 8 months at station 9.2, since it simply represents a three-times longer time span over which the data were aggregated (6 months vs 2 months).

Differences also occur due to the built-in response time of the model to changes in flow, which are gradual and may not reflect actual conditions that occur in the field. Finally, the model may predict that lower salinities will occur in the upper reaches of the river because relatively small amounts of tributary and groundwater inflow at the upstream end have a greater effect in the narrow channel of the river at those locations than they have in areas further downstream where the rivers widens.

Regarding the apparent differences among values based on the long-term salinity modeling effort in Tables 35, 36 and 37 with statistics based on measured flow records in Table 24. Because we have relatively good daily flow data, we can probably more accurately characterize the duration and magnitude of flow conditions much more precisely than we can characterize salinity. Not only do we have limited, incomplete and perhaps suspect salinity data to provide a basis for calibration and verification , the available data show wide ranges of variation for given flow values. The model was chosen because it provides a more or less consistent estimate of salinity and can account for some of the known sources of variability in the data (tidal cycles). However, we recognize that it may not provide a very accurate representation of conditions in the river at any particular point in time. We are assuming that these are largely randomized errors that will average out over a long period of record. We also recognize that the use of a long period of record increases the chances that we may be incorporating systematic errors that you noted in your comments, due to structural or management changes in the system that have affected the basic flow relationships, and may bias our long-term flow and salinity estimates at particular stations. We felt that this type of error was less important than being able to estimate how the system would perform under a wider range of hydrologic conditions that better represent the inter-annual patterns and cycles of flood and drought that occur in South Florida.

<u>Page 5, 5th Paragraph</u>: *I would suggest either working with the empirical relationships derived in Appendix D that relate flow to salinity or improving the model so that it does a better job of reproducing observed salinities. In either case, it seems like the historic salinity information is not relevant and the MFL can be set based on the current salinity regimes (e.g. it would be possible to determine what flows would be necessary to change salinity conditions at RM 9.2 such that they mimic what is currently observed at RM 10.2).*

- **District Staff's Response**: We have addressed this issue earlier in our response.

Page 5, 6th Paragraph: *Finally, I'm not sure I understand why the emphasis is on 2 ppt. If these salinities are thought to occur very rarely (e.g. the 99th percentile), then flows could theoretically be maintained at the 98th percentile without violating the MFL. However, maintaining a salinity of 1.9 at RM 9.2 would surely cause damage to the vegetation even further upstream in the River. Is the target actually to maintain average flows such that average salinity at RM 9.2 will be what is currently experienced at RM 10.2?*

District Staff's Response: **Page 5, 6th paragraph.**

- As shown in Figure 20 on page 99 for discharges from 1970 – 2001, the 2 ppt represents one point on a flow-frequency plot of overall river discharge. The actual flows from the dam will cover a range such as shown in the plot, wherein 2 ppt (35 cfs was exceeded about 70% of the time, the median flow was 65 cfs, flows of 200 cfs were exceeded 7% of the time etc. More recent data (see table 1 above) indicate that overall median (82 cfs) and high flows to the river have improved substantially, but the frequency of low flow events remains high (flows less than 35 cfs still occur 25% of the time). The intent is to shift this flow curve to a higher level, by reducing the frequency of flow events below 35 cfs to less than 1% but keeping the higher end flow events comparable to historic conditions.

Conclusion

Thank you for your insightful comments on this process. You have made us aware of many implicit assumptions that we have taken for granted by choosing to use the modeling approach and that, if left unresolved could ultimately reduce our ability to adequately protect this unique and valuable river. As you may be aware, we are in the process of upgrading this model to a 3-dimensional version and are collecting extensive synoptic flow and salinity data throughout this basin that we feel will provide the necessary information to address these issues in greater detail.

The MFL proposed in the draft document is intended to be an interim management target based on best available data. We envision the establishment of MFLs for the Loxahatchee River as an iterative process. Projects are already underway to meet the proposed flow of 35 cfs 94% of the time by 2006 and continue beyond that value to provide flows of 65 cfs 99% of the time by 2018. Studies are also underway to examine opportunities to enhance flows from other tributaries – Cypress Creek, Hobe Groves Ditch and Kitching Creek. The SFWMD is initiating studies with FDEP and other agencies to define overall restoration goals for the river that will not only include minimum flow criteria for the river but will also address needs for sustained average flows and periodic high flow periods that are needed to maintain a healthy river and floodplain and downstream estuary. It is anticipated that once the restoration goals for the river have been established in terms of desired flow and ecological conditions, that the MFL criteria will also have to be revised in order to be consistent with protection of the restored ecosystem from significant harm.

Additional Comments on Proposed MFL Criteria for the Loxahatchee River and Estuary
Submitted by: Merryl Alber Dept. of Marine Sciences, Univ. of Georgia
December 20, 2002

This is a response to the two documents that were sent to be by the district as a result of my comments on the July 2002 draft of the Loxahatchee River MFL. The first is the draft response to my peer review comments, and the second is a Technical Memo prepared by Dr. Gordon Hu regarding the hydrodyamic model and regression analysis.

District Response to review

The District has done a thorough job responding to the points raised in my draft review of the proposed MFL criteria for the Loxahatchee River and Estuary. I am pleased with this effort: many of the points I raised have either been taken into consideration or have been explained to my satisfaction. In a few cases, however, I feel there is a need for further discussion (page numbers below refer to the District's response document)

p. 2 Model calibration – the district has now provided color copies of the graphics presented in Appendix P. It is a little curious that the Figure for station 65 is the only one that provides output for both the calibration and verification stages of the model (only calibration is shown for station 64 and only verification for 66). Given this limited amount of information it is unfortunate that the model misses one large spike in the field data, and that field data are missing during much of the verification stage. I agree that as far as it goes the model does largely capture the range of the salinity observations, but it would be useful to see additional verification when the data become available. The model also seems to have a much larger dynamic range than field observations at station 64.

p. 3 Despite the model's problems, the District has decided that it is preferable to the regression analysis for predicting salinity under different flow regimes. I am willing to agree with this, but I have several points that I would still like to see addressed. These points are taken up below in my response to the Technical Memorandum by G. Hu.

p. 4, 1st paragraph My review suggested that historic salinity data, where available, could be used to spot-check model predictions of salinity at various places and times in the past. Appendix A describes several studies that might be appropriate for this purpose. This point does not seem to have been addressed.

p. 4-p. 5 The District suggests that the basin's storage capacity has not changed, and provides information to show that the flow duration curve derived for 1971-1984 is similar to that for 1990-2001 during low flow periods. However, the analysis in Table 24 of the original document (p. 98) suggests that even if the same percentage of time is spent at low flows, there are fewer events (35 periods during 1990-2001 where flow was less than 20 cfs versus 59 during 1971-1989) so it is not completely clear that the low flow conditions have not changed. The District might want to revisit this analysis.

Even if low flow hasn't changed, however, that does not justify using current flow/salinity relationships because the point is that closing the gaps has changed the river and thus the salinity could have changed even during the same flow. The analysis presented by Dr. Hu suggests these changes occurred downstream of RM 8, which is fortunate in terms of setting the MFL criteria. However, this point should not be ignored when evaluating predicted salinities further downstream.

On a minor point, I'm confused over why there is limited water storage capacity during dry periods. Wouldn't that be a more important consideration during wet periods?

p. 6. Whether or not there has been a measurable increase in salinity over the past decade is an important question that needs to be addressed. In my review I suggested that the District recalculate the information obtained from the Wild and Scenic Segment of the river without station 63 to determine if average salinities have in fact increased over the past decade (see p. 102). Either this or some other way to determine whether salinity has increased in response to the general increase in flow would be really useful.
This point is made at the bottom of p. 6 in the District's response, but the line on the top of p. 7 is not a response to this comment.

p. 9 and p. 13 I understand that the goal of the MFL is to try to apply the flow regime that now occurs at 10.2 to that at 9.2, and that in essence the proposed MFL was an attempt to shift the low end of the flow duration curve up by reducing the frequency of low flow events. I am concerned (as was Dr. Kent) that the District's choice of 35 cfs may not meet this goal. As we have both noted, an average flow of 100 cfs would be a better way of ensuring that salinities at RM 9.2 average 0.15, which is what they are at 10.2 Although the response explains that this was an attempt to define average conditions, it might be worth considering a statement that relates to the flow duration curve at more than one point (e.g. whenever flows are less than 35 cfs for more than 20 d (not more than once every 6 y) OR less than 47 cfs for more than 30 d (not more than once every 1.6 y) OR less than (use other percentiles…), etc. This would avoid the possibility that flows could be kept at slightly more than 35 cfs without consequence and might be more in keeping with the District's stated goal for the MFL.

p. 12 I'm still not convinced that the differences between the long-term salinity modeling effort and the flow statistics are due to "largely randomized errors" or that the potential bias in the long-term flow and salinity estimates is "less important than being able to estimate how the system would perform under a wider range of hydrologic conditions." The wide range of variation in observed salinities at a given flow suggests that the model does not account for all of the variables (besides the tidal cycle) that can potentially affect salinity. A smoothed model is perhaps more tractable, but if it is not accurate it does not make sense to use the model to predict the system performance. Although I am willing to accept that it is inappropriate to compare the flow data to the salinity observations (as I tried to do), this again comes down to the need for additional model verification (both with current data and with historic information) to reassure users that the model is appropriate.

Technical Memo

This memo is largely focused on the work that the District has done to evaluate the flow-salinity relationships derived from regression analysis and compare these results with those of the hydrodynamic model. I am pleased to see that the District has been so responsive to my comments in this regard. My comments below are both reactions to what has been done to-date and suggestions for further refinement of these comparisons.

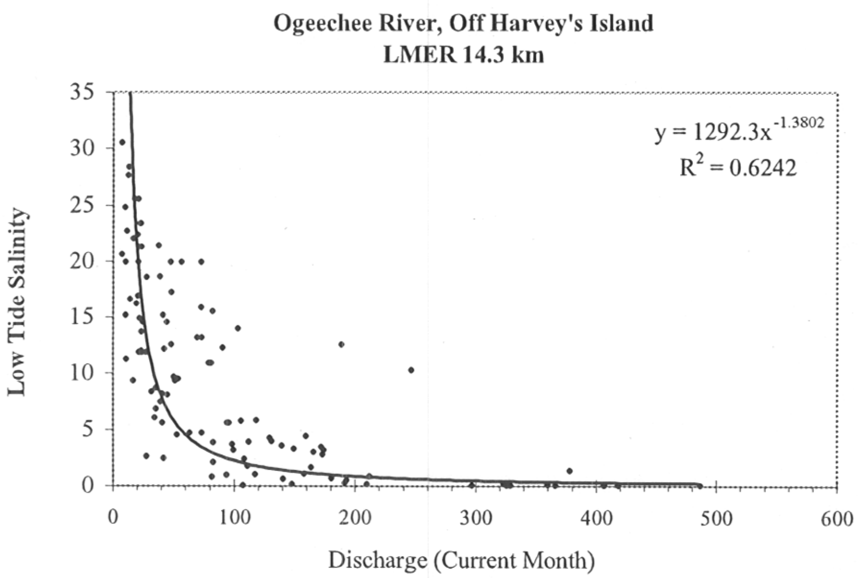
1. I am glad to see the District is pursuing the SAS analysis. When this analysis is complete, it would be nice to see the regressions and the statistics associated with them to know if they are indeed fitting the data well. If they are not, the next layer of analysis (e.g. as done in figure 3) is not warranted.

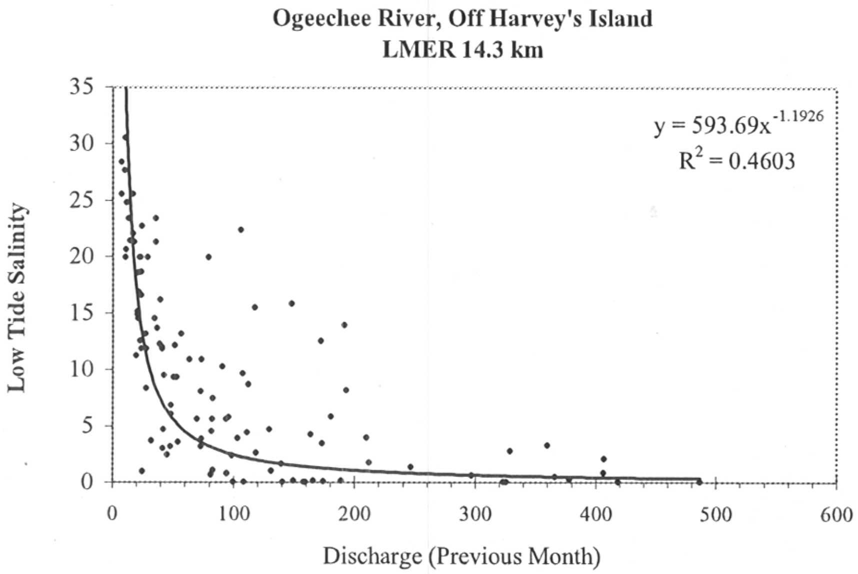
2. I agree that the SAS analysis presented for Station 64 does not provide a good fit for the high flow/low salinity data (although I might argue that it is the fit for Station 65, which is much better, that is more important in terms of the MFL). These fits could be improved by using a better time lag for data averaging.

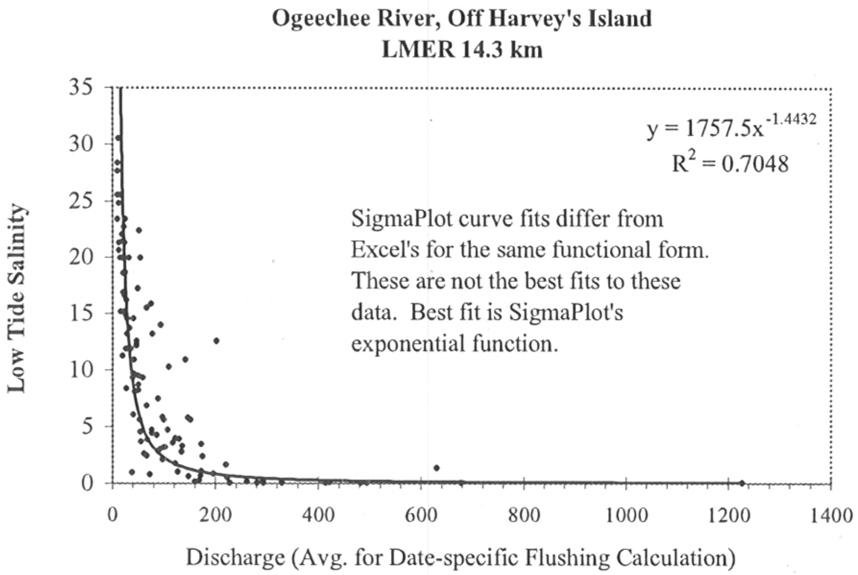
In our experience matching each observation with the appropriate discharge can substantially improve the "tightness" of the relationship between flow and salinity. I am enclosing graphs of 2 different sites in Georgia to illustrate this point. (These are large estuaries where monthly discharge seemed appropriate as a first cut.) In both cases the salinity observations are matched with a) the discharge during the month when the observation was made, b) the discharge averaged over the month previous to the observation, and c) discharge averaged over a variable period that depended on flow. Although it is necessary to IGNORE the equations on this graph (they were fit with EXCEL before we learned to do things better), it is clear that much of the variability in these observations was due to the changes in the discharge and could be reduced by taking that into account.

Another way to improve the fits is to use only a segment of the data (as has been done here). However, if the low flow/high salinity periods are most important I'm not sure it makes sense to focus on the 0-10 ppt range of the points. What happens to the SAS fits when one confines flows to less than 100 cfs and ignores the high end of the data?

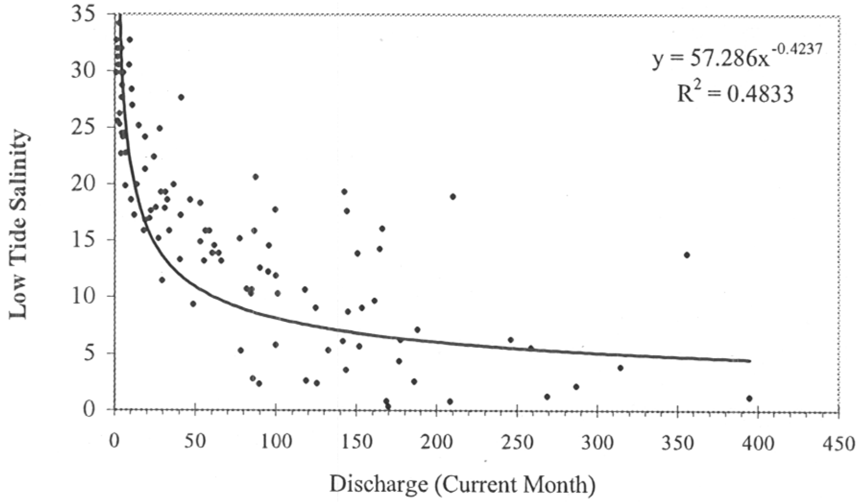
3. If I understand this properly, the "Linton" model is the one that was presented in the May 2001 draft MFL document. If so, this relationship is based on the EXCEL regressions, which we **know** are faulty (look at the curve fit for station 65 on page D-7 compared with p. D-21!). It is therefore not reassuring to see a close fit between the Linton and the hydrodynamic model.


Ogeechee River, Off Harvey's Island
LMER 14.3 km
y = 1292.3x^-1.3802
R^2 = 0.6242
Low Tide Salinity
Discharge (Current Month)
0
5
10
15
20
25
30
35
0
100
200
300
400
500
600

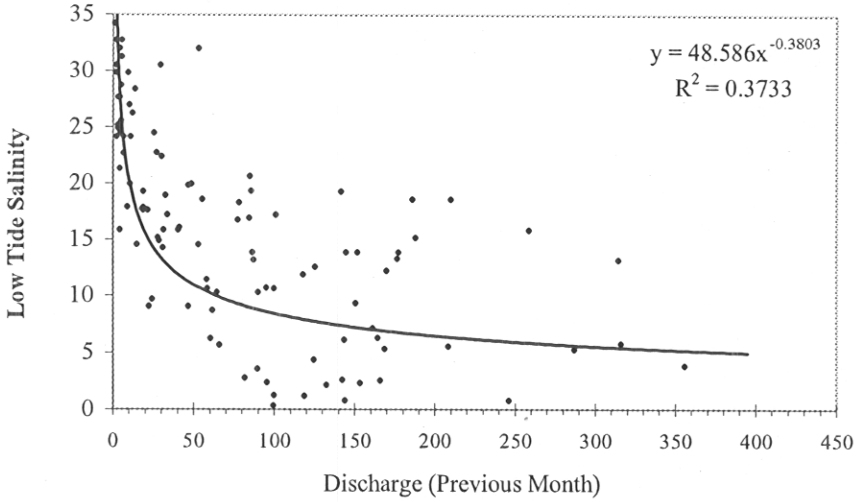

Ogeechee River, Off Harvey's Island
LMER 14.3 km
y = 593.69x^-1.1926
R^2 = 0.4603
Low Tide Salinity
Discharge (Previous Month)
0
5
10
15
20
25
30
35
0
100
200
300
400
500
600


Ogeechee River, Off Harvey's Island
LMER 14.3 km
y = 1757.5x^-1.4432
R^2 = 0.7048
SigmaPlot curve fits differ from Excel's for the same functional form. These are not the best fits to these data. Best fit is SigmaPlot's exponential function.
Low Tide Salinity
Discharge (Avg. for Date-specific Flushing Calculation)
0
5
10
15
20
25
30
35
0
200
400
600
800
1000
1200
1400

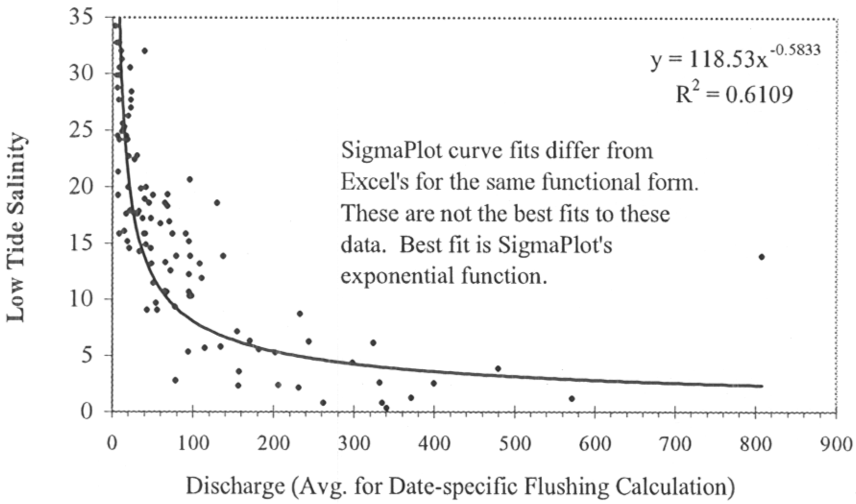
Satilla River, Buoy A15 on the Intracoastal Waterway
LMER 9.5 km



Satilla River, Buoy A15 on the Intracoastal Waterway
LMER 9.5 km



Satilla River, Buoy A15 on the Intracoastal Waterway
LMER 9.5 km



Summary and Recommendations:

I find that the District has adequately addressed most of my considerations with regard to the proposed MFL for the Loxahatchee River and Estuary. My final recommendations are summarized below:

1. Additional ground-truthing of the hydrodynamic model would be appropriate. This should involve both additional verification runs under current conditions as well as comparisons of historic salinity predictions with historic data, if available

2. It is critical to evaluate the data to see if salinity has in fact changed in the upstream portion of the river.

3. I suggest continuing the SAS analysis:
-relationships might be improved by re-evaluating which discharge to couple to with each observation
-consider using only the low flow portion of the data
-it would be useful to see graphs with the SAS fits and statistical analysis of the relationships

4. Consider rewording MFL to reflect the entire flow-discharge curve rather than focusing on one salinity/duration.